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## *On House Painting.*

House Painting is an art of great antiquity, and it is more than probable, that the earliest erections, of a durable nature, received some additions from the pencil of the artist. Painting, as applied to buildings, comprises, in the first place, the colouring of wood, iron, &c.; and to effect this, a pigment is spread over them with a brush, so that by a repetition of several coats, the material is preserved, and its appearance improved.

The object of this division of our work, is to give an account of some mechanical proceedings in certain kinds of painting, calculated to preserve and embellish the walls of houses, and furniture. This branch of the art, extends to every part of architecture. The whole building becomes the workshop of the artist; the stairs, the balustrades, the sashes, the doors, and the railing of all kinds, occupying his first care, and then the ceilings and wainscoting.

The artist gives to all his subjects, a chosen and uniform tint: but he has it in his power to vary the colours on different parts of the building, in such a manner as to produce the most pleasing effect.

Among the utensils of the painter, it is needless, but for rendering the article complete, to mention brushes and pencils, of all sizes, as absolutely necessary.

The brushes are made of boars' bristles, or of hair, with a mixture of bristles; they ought to be straight, very smooth, and of a round form. Half an hour before they are used, it is proper to soak them in water, in order to swell the wood of the handle, and prevent the hairs from falling off; after this, they may be applied to all purposes, either in water colours, or in oil: but it may be observed, that for the former, they require less softening.

The pencils are made of badgers' hair, or any fine hairs, encased in the pipes of quills of all sizes.

The vessel wherein the pencils are cleansed, is made of copper or of tin, smooth below, rounded at the ends, and divided into two parts by a thin plate in the middle. The oil, or the substance with which the pencil is cleansed, is contained in one of the divisions.

The palette is made of the wood of the pear or apple tree, of an oval, or a square shape, very slender, but somewhat thicker at the centre, than at the extremities. A hole is made in one of its sides, sufficiently large to admit the thumb of the workman.

When the palette is new, it is covered with oil of walnuts; and as often as it dries, the operation is repeated, till it be fully impregnated; it is afterwards polished, and finally rubbed with a piece of linen; dipped in oil of common nuts.

The painter's knife, is a thin, flexible plate, equally slender on both sides, rounded at one extremity, and the other fixed into a handle of wood.

All the vessels employed to hold the colours, should be varnished; a precaution necessary to prevent their drying too quickly; and they may be cleansed with a piece of marble, or any hard stone, by means of water, oil, or essence.

To grind, is to reduce to powder, the substances which give colours; and to dilute, is to impregnate a liquid, with a tint, in such a manner as to make it capable of being applied by a brush.

When the materials are ground in water, it is proper to dilute them, in size made from parchment. If they are diluted by spirit of wine, there must be no more diluted than what serves the immediate occasion, as colours prepared in this manner, dry very rapidly.

Colours ground in oil, are sometimes diluted with pure oil, more frequently with oil mixed with essence, and commonly with the simple oil of turpentine; the essence makes the colours easy to work.*

When colours are ground with the oil of turpentine, and diluted

* Oil of turpentine, or, as it is called, *turps*, is in general use in house painting, and is the ingredient by which the flatting, as it is termed, is performed. All the larch and fir-trees furnish a resin, known by the general name of turpentine. Commerce distinguishes several qualities according to its degree of goodness. The larch-tree furnishes what is called Venice turpentine; it is obtained by being made to flow from the trunk of the tree, through holes made with an auger, in which small pipes are fixed, that conduct the juice into buckets placed to receive it. This turpentine has a yellowish and limpid colour, a strong aromatic smell, and bitter taste. In Canada, the peasants collect it from the fir-tree by perforating the sacs, which contain it under the bark, with the point of a horn which is filled with this juice. It is afterwards distilled, on which it liberates an oil more or less volatile, according to the degree of heat employed. When the operation is done by a bath, a white, limpid, and odoriferous oil is obtained, which is called essence of turpentine. The residue from this distillation, forms the boiled turpentine of commerce. This is sold at the colour shops, in the same way in which oil is, viz. by the gallon. This as well as the oil, considerably improves by age: hence all painters, in a large way of business, keep it by them in quantities, which enables them to depend on their work retaining its colour: a circumstance of no little importance in our present mode of house painting.

in varnish, as they require to be immediately applied, it is necessary to prepare a small quantity at a time. This preparation of colours, gives greater brilliancy, and dries more speedily, than those prepared in oil; but they require more art to manage them.

They grind colours, or coloured substances, with a mullar, which is employed on the stone, till they become a very fine powder. The operation is facilitated by moistening them, from time to time, with a little water, and by collecting them under the mullar, with the knife. They are afterwards laid in small heaps on a sheet of white paper, and allowed to dry, in a situation not exposed to dust. Those who grind white lead, have a stone for that purpose only, as this colour is very easily tarnished. In executing this part, well, it is necessary to grind the colours equally, and moderately; to grind them separately, and not to produce a tint by mixture, till the colours are well prepared.

Dilute no more, at a time, than what you have occasion to employ, to prevent them from growing thick.

In grinding the colours, put in no more liquid than what is necessary to make the solid substances yield easily to the mullar: the more the colours are ground, the better they mix, and give a smoother and more agreeable painting.

It is also necessary to give all attention to the grinding and diluting of colours, that they may be neither too thick, nor too thin.

Prepare only the quantity necessary for the work you undertake, because they do not keep, long; and those which are newly mixed, are more vivid, and beautiful. Hold the brush straight before you, and allow only the surface to be applied to the subject; if you hold it inclined in any other direction, you will run the hazard of painting unequally. It is necessary to lay on the colours boldly, and with firm strokes; taking care at the same time, to spread them, equally over the surface, and not to fill up the moulding, and carved work. If this accident should happen, you must have a little brush to clean out the colours. Stir them frequently in the vessel, that they may preserve always the same tint, and that no sediment may remain at the bottom. Take care not to overcharge the brush with the colour. Never apply a second layer, till the first, or preceding one, be perfectly dry; which it is easily known to be, when, in bearing the hand gently over it, it does not adhere. In order to render this drying, more speedy and uniform, always make the layers as thin as possible. Before painting, it is necessary to prime the subject; that is, to give it a layer of size, or of white colouring oil, to fill up the pores, and render the surface, smooth: by this means, fewer layers of colour, or of varnish, are afterwards necessary. Every subject to be painted, or gilt with leaf gold, ought to have, first, a white ground; this preserves the colours fresh and vivid, and repairs the damage which they occasionally receive from the air.

To paint in water-colours, which, from its simplicity, should first occupy the artist's attention, is to do it in those which are ground in water and diluted in size. There are three kinds, of this painting; namely, the *common*, the *varnished*, and that which is called *king's*

*white*; but before entering on these, it is necessary to make some preliminary observations.

1. Take care that there be no grease on the subject; and if there be, scrape it off, or clean it with a lye, or rub the greasy part with garlic and wormwood.

2. Let the diluted colour, fall in threads from the end of the brush when you take it out of the vessel; if it adheres to it, it is a proof that it wants size.

3. Let all the layers, especially at the beginning, be laid on very warm, provided that the liquid be not boiling, which would effectually spoil the subject; and if on wood, expose it to crack. The last layer given immediately before the varnish, is the only one which ought to be applied, cold.

4. In very fine work, where it is necessary to have beautiful and solid colours, the subjects are prepared by size, and proper whites, which serve as a ground to receive the colour, and render the surface very equal, and smooth.

5. Whatever colour is to be laid on, the white ground is the best, as it assimilates most easily with the painting, which always borrows something of the ground.

To make the following details sufficiently plain, we shall take the measures, to which the quantity of colours are applied, at fathoms; that is to say, six feet in height, by six feet in breadth. We shall afterwards fix the quantity of materials, and of liquids, necessary to cover this surface. This, however, cannot be exactly defined; as some subjects imbibe the colours much more than others. The manner of employing them, also makes a difference; as habit, enables one to manage them to greater advantage, than another. And it is also to be observed, that the first layer will consume more than the second; and that a prepared subject, requires less than one which has not been so.

When we speak of a fathom, it must be understood of a smooth and equal surface; for if the wood is varied with mouldings and carving, there must be a difference in the quantity of colours. In general, it requires about a pound of colours, to paint a square fathom, in water-colours. In making up this quantity, take three-fourths of colours, ground in water, and to this add about six ounces of size, to dilute it.

Works which require no great care, or preparation, as ceilings and stair-cases, are generally painted in common water colours, *i. e.* with earths infused in water, and diluted in size.

For a common, white kind of this painting, steep Spanish white moderately pounded, in water, for two hours. Infuse a proper quantity of the black of charcoal, in water, for the same space of time: mix the black and white in the proportion that the tint requires; afterwards mix them up with a pretty strong size, sufficiently thick and warm, and apply them to the subject, in as many layers, as may be thought necessary. It requires about two pounds of white, in a pint of water, and a quantity of black, in proportion to the tint, together with a part of size, to cover a square fathom. If this be employed

on old walls, they must be well scraped, the dust brushed off with a hair broom, and washed, carefully, with lime water. If on new plaster, the colours require more size.

All kinds of colours may be ground in water only, when the tint is made; and when they have been infused in water, they must be mixed up with size.

The white *des carmes* is a manner of whitening interior walls, whereby they are rendered extremely beautiful. To effect this, procure a quantity of the very best lime, and pass it through fine linen; pour it into a large tub, furnished with a spigot, at the height equal to that which the lime occupies: fill the tub with clear spring-water; beat the mixture with instruments of wood, and then allow it to settle for 24 hours.

Open the spigot, allow the water to run off, supply the tub with fresh water, and continue this operation for several days, until the lime receives the greatest degree of whiteness.

When you allow the water finally to run off, the lime will be found in the consistency of paste; but with the quantity you use, it is necessary to mix a little Prussian blue, or indigo, to relieve the brightness of the white, and a small quantity of turpentine, to give it brilliancy. The size proper for it, is made of glove-leather, with the addition of some alum; and the whole is applied with a strong brush, in five or six layers, to new plaster.

The wall is rubbed over, strongly, with a brush of hog's bristles, after the painting is dry; which gives it its lustre and value, and which makes it appear like marble or stucco.

*Badegeon* is a pale yellow colour, applied to plaster to make it appear like free stones. It gives to old houses, and churches, the exterior of a new building, by assuming the colour of stones newly cut. Take a quantity of lime, newly slaked; add to it the half quantity of what the French call *sciure de pierre*, in which you have mixed a quantity of the ochre of *rue*, according to the colour of the stone you intend to imitate. Steep the whole in a pail of water, in which is melted a pound of rock alum. When the *sciure de pierre* cannot be obtained, it is necessary to use a greater quantity of ochre *de rue*, or of yellow ochre, or grind the scales of the stone de St. Leu; pass it through a sieve; and along with the lime, it will form a cement, on which the weather will scarcely make any impression.

When the ceilings or roofs are new, and you wish to whiten them, take white of Bougival, to which add a little of the black of charcoal, to prevent the white from growing reddish: infuse them, separately, in water; mix the whole with half water, and half size of glove-leather, which, being strong, would make the layer come off in rolls, if it were not reduced with water. Give two layers of this tint, while it is lukewarm. If the roof has been formerly whitened, it is necessary to scrape to the quick, all the remaining white; then give it two or three layers of lime, to ground, and whiten it. Brush it carefully over, and give it two or three layers of the white of Bougival, prepared as before.

To finish the fire-places, clean them with a very strong brush, and

carefully rub off the dust and rust; pound about a quarter of a pound of lead ore into a fine powder, and put it into a vessel with a half pint of vinegar; then apply it to the back of the chimney with a brush: When it is made black with this liquid, take a dry brush, dip it in the same powder without vinegar, and dry and rub it, with this brush, till it become shining as glass.

The advantages of this kind of painting, are, that the colours do not fade; that they reflect the light; that they give no offensive smell, but permit the places to be inhabited as soon as finished; and that the varnish preserves the wood from insects, and moisture.

To make a fine varnish on water-colours, seven principal operations are necessary; namely, to size the wood, to prepare the white, to soften and rub the subject, to clean the moulding, to paint, to size, and to varnish.

To size the wood, is to give one or two layers of size, to the subject which you intend to paint. To make which, in the most perfect manner, take three heads of garlic, and a handful of wormwood leaves; boil them in three pints of water, till they are reduced to one; pass the juice through a linen cloth, and mix it with a pint of parchment size; add half a handful of salt, and half a pint of vinegar; and boil the whole on the fire.

Size the wood with this boiling liquor; allow it to penetrate into the carved and smooth places of the wood, but take care, at the same time, to take it as clean off the work as possible, or, at least, to leave it at no one place thicker than at another. This first sizing, serves to fill up the pores of the wood, and to prevent the materials afterwards from collecting in a body, which would cause the work to fall off in scales.

In a pint of strong parchment size, to which you have added four pints of warm water, put two handfuls of white Bougival, and allow it to infuse, for the space of half an hour; stir it well, and give a single layer of it, to the subject, very warm, but not boiling, equally and regularly laid on, and dashed with repeated strokes of the brush, into the mouldings and carved work.

To prepare the white, take a quantity of strong parchment size, and with the hand, sprinkle lightly over it, Bougival white, till the size be covered with it, about half an inch in thickness; allow it to soak, for half an hour, as near the fire as to keep it milk warm; and then stir it with the brush till the lumps are broken, and it be sufficiently mixed.

Give seven, eight, or ten layers of this white, or as many as the nature of the work, or the defects in the wood shall render necessary, giving more white to the parts which require to be softened; but, in general, the layers must be equal, both with regard to the quantity of the white, and the strength of the size.

The last layer of the white, ought to be clearer than the rest, and is made so by adding water. It must be applied more slightly, taking care, with small brushes, to cover all the difficult places in the mouldings and carved work. It is necessary also, between the drying of

the different layers, to fill up all the defects with white mastich and size.

The work being dry, take little pieces of white wood, and of pumice-stone, ground for the purpose into all necessary forms, either for the panels, or the mouldings. Take cold water, (heat being destructive of this kind of work, it is common in summer, to add a little ice;) soften the wall with a brush, but only as much, at a time, as you can easily work, as the water might dilute the white, and spoil the whole; then smooth, and rub it with the pumice-stones, and the small pieces of wood: wash it with a brush as you smooth it, and rub it over with a piece of new linen, which gives a fine lustre to the work.

The mouldings, and carved work, are cleaned with an iron knife; and the only thing to be attended to, in the operation, is not to raise the grain of the wood.

The subject, thus prepared, is ready to receive the colour you intend to give it. Choose your tint; suppose a silver colour.

Grind white ceruse, and Bougival white, separately, in water, of each an equal quantity, and mix them together. Add a little blue of indigo, and a very small quantity of black of charcoal from the vine-tree, very fine, ground also separately, and in water; more or less of the one, or the other, gives the tint you require. Dilute this tint in strong parchment size; pass it through a bolting cloth of silk, very fine, and lay the tint on your work, taking care to spread it very equally; and then give it two layers, and the colour is applied.

Make a weak, beautiful, and clean size; stir it till it cools; strain it through a fine cloth, and give two layers to the work with a soft painting brush, which has been used, but which you have been careful to clean. Take care not to choak up the mouldings, nor to lay on the size, thicker on one place than another, and spread it over the work very slightly, otherwise the colours will be injured, and undulations in the painting will be the result.

The beauty of the work depends on this last sizing; for if any part is omitted, the varnish will penetrate into the colours and give it a darker shade.

When the sizing is dry, lay on two or three layers of spirit of wine varnish, taking care that the place on which you lay it, be warm, and the work is finished. [*Partington's Mechanic's Gallery.*

(TO BE CONTINUED.)

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ON THE NATURE AND PROPERTIES OF TIMBER.

*Extracted from "The Elementary Principles of Carpentry, by Thomas Tredgold."*

[Continued from page 291.]

*Description of Woods.**

CLASS I.

THE first class contains all woods that have larger transverse septa

* As the species described by Tredgold, are not, in general, the same with those used in this country, we shall select a small part only of this article, with a hope that it may awaken attention to a subject which has been too much ne-

(silver grain). The woods of this class, are compact, hard, and heavy; never very deep coloured, the oak being the darkest coloured of the class; they are nearly free from smell, and never resinous.

This class is formed into two divisions; one, containing those woods, in which the annual rings are distinctly porous on one side, and compact, or nearly compact, on the other; the other division, contains those in which the annual rings are sensibly uniform, and only to be distinguished by a difference of colour.

*Division* I.—In this division, I have only observed one species, the oak, which is universally allowed to be the best of woods.

1. Oak.—Of the oak (the *Quercus* of botanical writers) there are several species, which produce valuable timber. Vitruvius enumerates five kinds, viz. the esculus, the cerrus, the quercus, the suber, and the robur; the timber of each, being distinguished by its peculiar properties: but it would be difficult to identify some of the kinds mentioned by him, with the species described by botanical writers. Vitruvius, by his observations, shows that the qualities of the different species were attended to, and they must also have been well understood by the Gothic builders in this country, for in the roofs and beams of most of their buildings, we find a very superior kind of oak, which sometimes closely resembles, and is often mistaken for, chesnut. I have heard this kind of oak called the "Irish oak." Evelyn commends the Irish oak "for resisting the worm;" but to what species of oak he alludes, I have not been able to determine.

In general, the English oak is spoken of by practical men, as though there were but one species, and no difference in the quality of the wood, except that produced by soil and situation; but two distinct species have been long known to English botanists; and it appears from the observations and inquiries I have made, that the kinds which are common in different districts, are different species. I have not been able to extend my observations on this point, so far as I was desirous of doing, but as the different species differ materially in their properties, it is of national importance that the best species for ship-timber, should be most commonly cultivated; therefore I hope the investigation will be continued by some one more competent to the task.

Common British oak (*Quercus robur*) is found throughout the temperate parts of Europe, and is that which is most commonly met with in the woods and hedges of the south of England.

The leaves of this species are, irregularly situated, with short, or

glected by us, but which is beginning to force itself upon our notice, in consequence of the rapid decrease of some kinds of timber, which have been improvidently wasted, in our most populous districts. The period has arrived, when the relative value of the varied productions of our forests, whether employed for their beauty, strength, or durability, may be correctly estimated; most of our woods having been in use for a number of years, and in all the varieties of situation requisite to enable us to estimate the latter property. Our engineers, naval architects, and builders, might furnish individual observations, which, when collected and compared, would be invaluable.

The tabular experiments will serve to show the manner of presenting the result of observations on the strength of timber. [Editor.

scarcely any footstalks; the acorns have long stalks. In favourable situations, this species attains an immense size. A fine healthy tree, now growing (1820) in the grounds of Earl Cowper, at Panshanger, Herts, measures nearly 18 feet in circumference, at 5 feet from the ground; and the whole height of the tree exceeds 75 feet.

The wood of this species has often a reddish tinge; the larger septa are always very numerous, producing large flowers; the grain is tolerably straight and fine, and it is generally free from knots; sometimes closely resembling foreign wainscot. It splits freely, and makes good laths for plasterers and slaters; and it is decidedly the best kind of oak for joists, rafters, and for any other purposes where stiff and straight grained wood is desirable.

The sessile-fruited oak, bay-oak of Bobart, Norwood oak of Martyn *(Quercus sessiliflora)* is a native of the woods and hedges of the temperate parts of Europe, and appears to have been first noticed as a distinct species, in this country, by Mr. Bobart, in Bagley Wood, and near Newbury, in Berkshire. It has been observed by Miller, near Dulwich, in Surry; and it appears to be the common oak of the neighbourhood of Durham, and perhaps generally of the north of England.

Thes' trength, elasticity, toughness, and hardness of the sessile-fruited oak render it superior for ship-building, but it is both heavier, and more difficult to work, than the robur; how far they may differ in durability, remains to be determined. The wood for the old *Sovereign of the Seas*, was from the north: is it not probable that the greater part of it was of the sessile-fruited oak? The hardness of the timber, "when taken in pieces after forty-seven years' service," is in favour of this conjecture.

In order to make experiments on the two species, when grown at the same place, and nearly of the same age, I was supplied with specimens by Mr. Atkinson.

The trees were cut a little before the fall of the leaf, and being cut into small scantlings, after drying two months, they were submitted to experiment.

The following table shows the results of trials on two pieces, each piece an inch square, and sustained by supports 24 inches apart, the weight being applied in the middle of the length.

| Species of oak. | Specific gravity. | Weight of a cubic foot in pounds. | Comparative stiffness or weight that bent the piece, seven twentieths of an inch. | Comparative strength or weight that broke the piece. |
|---|---|---|---|---|
| | | | pounds. | pounds. |
| Quercus robur. | ·807 | 50·47 | 167 | 322 |
| Quercus sessiliflora | ·879 | 54·97 | 149 | 350 |

Both these specimens broke short without splitting, therefore these experiments offer a very fair view of the properties of the two species. The sessiliflora bent considerably more at the time of fracture than the robur, but it could not be measured with that correctness which is necessary to render such data useful.

The following table contains the values of the cohesive force, and modulus of elasticity, calculated from the above experiments.

| Species of oak. | Cohesive force of a square inch in pounds. | Weight of modulus of elasticity in pounds for a square inch. | Comparative toughness. |
|---|---|---|---|
| Quercus robur . . | 11,592 | 1,648,938 | 81 |
| Quercus sessiliflora . | 12,500 | 1,471,256 | 108 |

These pieces were hastily, and therefore imperfectly, seasoned; but as they were treated exactly alike, this would not effect the comparison.

There is another species, called the Durmast oak, which is a native of France, and the south of England; its wood is not so strong, nor of so firm a texture, as the English oak, and it retains its foliage much later.

The Austrian oak, is a taller tree than the English oak, but the wood is whiter, softer, and less valuable.

Of the American species, the chesnut-leaved oak is a tall tree, remarkable for the beauty of its form; the wood is coarse grained, but is very serviceable, and is much used for wheel carriages.

The mountain red oak *(Quercus rubra)* is a native of Canada, and the country west of the Alleghany mountains; it is called the red oak, from the leaves changing to a red, or purple colour, before they fall off. It is a large and fine tree, of 90 or 100 feet in height, and of rapid growth; the wood is useful for many purposes, but it is light, spongy, and not very durable.

The white oak, *(Quercus alba,)* so called from the whiteness of its bark, is a native of the woods from New England to Carolina, and acquires an immense size, in some of the middle states. Its wood is tough and pliable, and it is preferred to all others, in America, for both house and ship carpentry, being much more durable. It is less durable than British oak, but it is of a quicker growth.

The blunt-lobed, iron oak, is another of the American species, that produces very valuable ship-timber; the wood is hard, and not liable to decay, and is preferred for fencing. It is found in most of the upland forests, from Canada to Florida, and is a tree of 60 or 70 feet in height.

The species of the Riga oak, so valuable on account of the straightness of its grain, and freedom from knots, does not appear to have been determined: neither have I been able to find from what species the Dutch wainscot is obtained; it is grown in the forests of Germany and floated down the Rhine.

According to Hassenfratz, the mean size of the trunk of the

| | | |
|---|---|---|
| Common oak is | 45 feet in length; and | 32 inches diameter. |
| White American oak | 58 | 35 |
| Red American oak | 48 | 32 |

Oak, of a good quality, is more durable than any other wood that attains a like size. Vitruvius says, it is of eternal duration, when driven into the earth; it is well known to be extremely durable in water; and in a dry state, it has been known to last nearly 1000 years. The more compact it is, and the smaller the pores are, the longer it

will last; but the open, porous, and foxy-coloured oak, which grows in Lincolnshire and some other places, is not near so durable. Mr. Chapman very justly observes, that the heart, of such oak, is scarcely superior to the sap, of better kinds.

The chief use of oak is for ship-timber; the consumption of oak, for the construction and repair of the British navy, in 1788, exceeded 50,000 loads of timber. It is also useful for most of the purposes of the carpenter, and particularly in situations where it is exposed to the weather. It makes the best wall-plates, ties, templets, king-posts, and indeed it is best suited for every purpose, where its warping in drying, and its flexibility do not render it objectionable; but, as Vitruvius has observed, it is very subject to twist, and occasion cracks in the work it is employed in.

The colour of the oak is a fine brown, and is familiar to every one; it is of different shades; that inclined to red is the most inferior kind of wood. The larger transverse septa are, in general, very distinct, producing beautiful flowers, when cut obliquely. Where the septa are small, and not very distinct, the wood is much the strongest. The texture is alternately compact and porous; the compact part of the annual ring being of the darkest colour, and in irregular dost, surrounded by open pores, producing beautiful dark veins, in some kinds, particularly in pollard oaks.

It has a peculiar smell, and the taste is slightly astringent. It contains gallic acid, and is blackened by contact with iron, when it is damp.

The young wood of English oak, is very tough, often cross grained, and difficult to work. Foreign wood, and that of old trees, is more brittle and workable.

Oak, warps and twist much in drying, and shrinks about one-thirty-second part of its width, in seasoning, according to Mr Couch's experiments.

The cohesive force of oak, varies from 7,850 to 17,899 pounds per square inch. The mean of Mr. Barlow's experiments is 10,000 pounds. I have taken 11,880 as a standard to compare with the other woods, being the result of an experiment on a specimen of a mean quality.

The weight of the modulus of elasticity, for a square inch, is 1,714,500 pounds, from a mean of various specimens.

The weight of a cubit foot of different kinds, is as under:

| | |
|---|---|
| English oak, from - - - | 45 to 58 pounds, seasoned. |
| Riga oak - - - - - - - | 43 to 54 |
| Red American oak - - - | 37 to 47 |
| White American oak - - | 50 to 56 |
| Adriatic oak - - - - - | 58 to 68 |

Representing the strength, stiffness, and toughness of the common English oak *(quercus robur)* each by 100, it may be compared with the other kinds, as under:

| | Common English oak. | Riga oak. | American oak. | Dantzic oak. |
|---|---|---|---|---|
| Strength . . . | 100 | 108 | 86 | 107 |
| Stiffness . . . | 100 | 93 | 114 | 117 |
| Toughness . . | 100 | 135 | 64 | 99 |

It is necessary to observe, that the specimens of Riga and Dantzic oak, were of the best quality.

*Division* II.—In the second division, there are several species; I have described only four; the beech, alder, plane, and sycamore. The woods of this division, are very uniform in their texture, and very durable in water; they are useful for piles and planking in wet situations, but not applicable to other kinds of carpenters' work. Woods of this division do not warp so much as those of the first division.

1. Beech.—Of the beech tree, the *Fagus sylvatica* of botanists, there is one species, the common beech; the difference in the wood, proceeding, according to Miller, from the difference of soil and situation; but owing to this difference, the wood is distinguished by the names brown or black, and white beech.

Beech is durable when constantly immersed in water, but damp soon destroys it. In a dry state it is more durable; but is soon injured by worms, whether it be in a damp, or in a dry state. Duhamel observes that water-seasoned beech is much less subject to worms, than that seasoned in the common way; and Ellis says, to preserve it from worms, it ought to be cut about a fortnight after midsummer, and planked immediately; then the planks should be put in water about ten days, and afterwards dried.

Beech is not useful in building, because it rots so soon, in damp places, but it is useful for piles, in situations where it will be constantly wet; and it is very useful for various tools, for which its uniform texture and hardness, render it superior to any other wood: it is also much used for furniture, and great quantities are brought to London in boards and planks. Before cast iron was introduced, much beech was used for rail-ways for the collieries about Newcastle.

The colour of beech is a whitish brown, of different shades; the darker kind is called brown, and sometimes black beech; the lighter kind, is called white beech. The texture is very uniform; the larger septa are finer, and do not extend so far in the length of the wood, as in oak, therefore the flowers are smaller. The annual rings are rendered visible by being a little darker on one side, than on the other. It is very uniformly porous, and might be easily made to imbibe some ingredient that would prevent the worms destroying it.

It has no sensible taste or smell, it is not very difficult to work, and may be brought to a very smooth surface.

The white kind is the hardest, but the black, is tougher; and Evelyn says it is more durable, than the white.

The cohesive force of a square inch of beech, varies from 6070 to 17,000 pounds; the weight of its modulus of elasticity, is about 1,316,000 pounds; the weight of a cubit foot, dry, varies from 43 to 53 pounds. The higher numbers are from Muschenbroek, both in cohesive force and weight, and they are certainly much above any I have observed, as well as much above those of any other writer: about 12,000 pounds is its mean cohesive force.

Representing the strength of oak by 100, that of beech will be 103
stiffness of oak by 100, - - - - - - - 77
toughness of oak by 100, - - - - - - - 138

Hence it appears that oak is superior in stiffness, but neither so strong, nor so tough.

2. ALDER.—The alder tree is the *Betula alnus* of botanists, a native of Europe and Asia, that grows in wet grounds, and by the banks of rivers. The tree seldom exceeds 40 feet in height.

The wood is extremely durable in water, or wet ground. Vitruvius has remarked, that in a wet state it will sustain the weight of very heavy piles of building, without risk of accident; and that the whole of the buildings at Ravenna, which is situate in a marsh, were founded upon piles of this wood. Evelyn says, he finds they used it under that famous bridge at Venice, the Rialto, which was built in 1591, or 228 years ago. But it soon rots when exposed to the weather, or to damp; and in a dry state, it is much subject to worms.

3. PLANE TREE.—Of the plane tree there are several species. The most common, are the oriental plane, and the occidental plane.

The oriental plane (*Platanus orientalis*) is a native of the Levant, and other eastern countries, and is considered one of the finest of trees. It attains about 60 feet in height, and has been known to exceed eight feet in diameter. Its wood is much like beech, but more figured, and is used for furniture, and things of a like nature. The Persians employ it for their furniture, doors, and windows.

The occidental plane (*Platanus occidentalis*) is a native of North America, and is, perhaps, one of the largest of the American trees; on the fertile banks of the Ohio and Mississippi, some of the trees exceed twelve feet in diameter. It is, sometimes, called water-beech, and sycamore; but the wood called sycamore, in this country, is a species of maple. The wood of the occidental plane, is harder than that of the oriental kind; but the occidental, is the most common in Britain, and to it only, the rest of this article applies.

The colour of the wood of the plane tree, is nearly the same as that of beech, and it also closely resembles it in structure; but it differs in the larger septa; as in the plane, the septa are more numerous, producing very beautiful flowers, when properly cut. It works easily, and stands very well.

The cohesive force of a square inch, is about 11,000 pounds; its modulus of elasticity, is 1,343,000 pounds per square inch; and it weighs from 40 to 46 pounds per cubic foot, when dry.

Representing the strength of oak by 100, that of plane tree will be 92
stiffness of oak by 100, - - - - - - - - 78
toughness of oak by 100, - - - - - - - - 108

The wood of the occidental plane, is very durable in water; and on that account, the Americans use it for wooden quays, in preference to any other kind.

4. SYCAMORE.—The sycamore or great maple, (*Acer pseudo-platanus*) generally called the plane tree, in the north of England, is a native of the mountains of Germany, and is very common in Britain.

It is a large tree, and of quick growth; it thrives well, near the sea. According to Hassenfratz, the mean size of its trunk, is about 32 feet in length, and 29 inches in diameter. Evelyn says, that in

Germany they have a better variety, than the one which grows in Britain.

The wood is durable in a dry state, when it can be protected from worms, but it is equally as subject to be destroyed by them, as beech. It is used chiefly for furniture, and the white wood of this tree, is valuable for many ornamental articles.

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*A century of the Names and Scantlings of Inventions. By the* MARQUIS OF WORCESTER.

(Continued from page 323.)

51. A rule of gradation, which, with ease and method, reduceth all things to a private correspondence, most useful for secret intelligence.

52. How to signify words, and a perfect discourse, by jangling of bells of any parish church, or by any musical instrument within hearing, in a seeming way of tuning it, or of an unskilful beginner.

53. A way how to make hollow, and cover a water-screw, as big and as long as one pleaseth, in an easy and cheap way.

54. How to make a water-screw tight, and yet transparent and free from breaking, but so clear that one may palpably see the water, or any heavy thing, how and why it is mounted by turning.

55. A double water-screw, the innermost to mount the water, and the outermost for it to descend more in number of threads, and, consequently, in quantity of water, though much shorter than the innermost screw by which the water ascendeth—a most extraordinary help for the turning of the screw to make the water rise.

56. To provide and make, that all the weights of the descending side of a wheel, shall be perpetually further from the centre, than those of the mounting side, and yet equal in number and heft to* the one side as the other. A most incredible thing, if not seen, but tried before the late king (of blessed memory†) in the tower, by my directions, two extraordinary embassadors accompanying his majesty and the Duke of Richmond and Duke Hamilton, with most of the court attending him. The wheel was 14 foot over, and 40 weights of 50 pounds a-piece. Sir William Balfore,‡ then Lieutenant of the Tower, can justify it, with several others. They all saw, that no sooner these great weights passed the diameter line of the lower‖ side, but they hung a foot further from the centre; nor no sooner passed the diameter line of the upper side, but they hung a foot nearer. Be pleased to§ judge the consequence.

57. An ebbing and flowing water-work, in two vessels, into either of which, the water standing at a level, if a globe be cast in, instead of rising, it presently ebbeth, and so remaineth until a like globe be cast into the other vessel, which the water is no sooner sensible of, but that¶ vessel presently ebbeth, and the other floweth, and so con-

* "Of."
† "Of happy and glorious," &c.
‡ "Sir W. Belford."
‖ "Upper."
§ "Lower."
¶ "The."

tinueth ebbing and flowing, until one or both of the globes be taken out, working some little effect besides its own motion, without the help of any man within sight or hearing: but if either of the globes be taken out, with ever so swift or easy a motion, at the very instant the ebbing and flowing ceaseth; for if, during the ebbing, you take out the globe, the water of that vessel presently returneth to flow, and never ebbeth after, until the globe be returned into it, and then the motion beginneth as before.

58. How to make a pistol to discharge a dozen times with one loading, and without so much as once new priming requisite, or to change it, out of one hand into the other, or stop one's horse.

59. Another way, as fast and effectual, but more proper for carabines.

60. A way, with a flask appropriated unto it, which will furnish either pistol or carabine with a dozen charges in three minutes' time, to do the whole execution of a dozen shots, as soon as one pleaseth, proportionably.

61. A third way, and particular for musquets, without taking them from their rests to charge or prime, to a like execution, and as fast as the flask, the musquet containing but one charge at a time.

62. A way for a harquebuss, a crock, or ship musquet, six upon a carriage, shooting with such expedition, as, without danger, one may charge, level, and discharge them, sixty times in a minute of an hour, two or three together.

63. A sixth way, most excellent for sakers, differing from the other, yet as swift.

64. A seventh, tried and approved before the late king (of ever blessed memory,) and a hundred Lords and Commons, in a cannon of eight inches half quarter, to shoot bullets of 64 pounds weight, and 24 pounds of powder, twenty times in six minutes; so clear from danger, that, after all were discharged, a pound of butter did not melt, being laid upon the cannon britch, nor the green oil discoloured that was first anointed and used between the barrel thereof; and the engine having never in it, nor within six foot of it, but one charge at a time.

65. A way that one man, in the cabin, may govern the whole side of ship musquets, to the number (if need require) of 2 or 3000 shots.

66. A way that, against several avenues to a fort or castle, one man may charge 50 cannons playing, and stopping when he pleaseth, though out of sight of the cannon.

67. A rare way, likewise, for musquetoons fastened to the pummel of the saddle, so that a common trooper cannot miss to charge them with twenty or thirty bullets at a time, even in full career.

*When I first gave my thoughts to make guns shoot often, I thought there had been but one only exquisite way inventible, yet by several trials, and much charge, I have perfectly tried all these.*

68. An admirable and most forcible way to drive up water by fire, not by drawing or sucking it upwards, for that must be, as the philosopher calleth it, *infra sphæram activitatis*, which is but at such a distance. But this way hath no bounder, if the vessels be strong

enough; for I have taken a piece of a whole cannon, whereof the end was burst, and filled it three-quarters full of water,* stopping and screwing up the broken end, as also the touch-hole, and making a constant fire under it, within 24 hours it burst, and made a great crack: so that having a way† to make my vessels, so that they are strengthened by the force within them, and the one to fill after the other, I have seen the water run like a constant fountain-stream, 40 foot high; one vessel of water, rarified by fire, driveth up 40 of cold water. And a man that tends the work is but to turn two cocks, that one vessel of water being consumed, another begins to force and refill with cold water, and so successively, the fire being tended and kept constant, which the selfsame person may likewise abundantly perform in the interim between the necessity of turning the said cocks.

69. A way how a little triangle screwed key, not weighing a shilling, shall be capable‡ and strong enough to bolt and unbolt, round about a great chest, an hundred bolts, through 50 staples, two in each, with a direct contrary motion, and as many more from both sides and ends; and at the selfsame time, shall fasten it to the place, beyond a man's natural strength to take it away; and, in one and the same turn, both locketh and openeth it.

70. A key, with a rose-turning pipe, and two roses, pierced through endwise the bit thereof,‖ with several handsomely contrived wards, which may likewise do the same effects.

71. A key, perfectly square, with a screw turning within it, and more conceited than any of the rest, and no heavier than the triangle-screwed key, and doth the same effects.

72. An escutcheon to be placed before any of these locks, with these properties:—

1st. The owner (though a woman) may, with her delicate hand, vary the ways of coming to open the lock ten millions of times, beyond the knowledge of the smith that made it, or of me who invented it.

2nd. If a stranger open it, it setteth an alarm a-going, which the stranger cannot stop from running out; and, besides, though none should be within hearing, yet it catcheth his hand, as a trap doth a fox; and though far from maiming him, yet it leaveth such a mark behind it, as will discover him if suspected; the escutcheon, or lock, plainly showing what monies he hath taken out of the box to a farthing, and how many times opened since the owner had been at it.

73. A transmittable gallery over any ditch or breach in a town wall, with a blind and parapet cannon proof.

74. A door, whereof the turning of the key, with the help and motion of the handle, makes the hinges to be of either side, and to open either inward or outward, as one is to enter or to go out, or to open in half.

75. How a tape or riband-weaver may set down a whole discourse,

* "Full."—merely.
† "Found a way."
‡ "Triangle *and* screwed key shall be capable."
‖ "Together."

without knowing a letter, or interweaving any thing, suspicious of other secret than a new-fashioned riband.

76. How to write in the dark, as straight as by day, or candle-light.

77. How to make a man to fly, which I have tried with a little boy of ten years old in a barn, from one end to the other, on an hay-mow.

78. A watch to go constantly, and yet needs no other winding from the first setting on the cord or chain, unless it be broken; requiring no other care from one man, than to be now and then consulted with, concerning the hour of the day or night; and if it be laid by, a week together, it will not err much, but the oftener looked upon, the more exact it showeth the time of the day or night.

79. A way to lock all the boxes of a cabinet (though never so many) at one time, which were by particular keys, appropriated to each lock, opened severally and independent the one of the other, as much as concerneth the opening of them, and by these means cannot be left open unawares.

80. How to make a pistol barrel, no thicker than a shilling, and yet able to endure a musquet proof of powder and bullet.

81. A comb-conveyance carrying of letters, without suspicion, the head being opened with a needle-screw drawing a spring towards them,* the comb being made but after an usual form carried in one's pocket.

82. A knife, spoon, or fork, in an usual portable case, may have the like conveyances in their handles.

83. A rasping-mill, for hartshorn, whereby a child may do the work of half-a-dozen men, commonly taken up with that work.

84. An instrument, whereby persons ignorant of arithmetic, may perfectly observe numerations and subtractions of all sums and fractions.

85. A little ball, made in the shape of a plum or pear, being† dexterously conveyed or forced into a body's mouth, shall presently shoot forth such, and so many bolts, of each side, and at both ends, as, without the owner's key, can neither be opened or filed off, being made of tempered steel, and as effectually locked, as an iron chest.

86. A chair, made *à la mode*, and yet a stranger being persuaded to sit down in't, shall have, immediately, his arms and thighs locked up beyond his own power to loosen them.

87. A brass mould, to cast candles, in which a man may make 500 dozen in a day, and add an ingredient to the tallow, which will make it cheaper, and yet so that the candles shall look whiter, and last longer.

88. ‡How to make a brazen or stone head, in the midst of a great field, or garden, so artificial and natural, that though a man speak never so softly, and even whisper into the ear thereof, it will presently open its mouth, and resolve the question in French, Latin, Welsh, Irish, or English, in good terms uttering out of his mouth, and then shut it until the next question be asked.

* "One." † "Which being."

‡ "An engine without the least noise, knock, or use of fire, to coin and stamp 100 lb. in an hour by one man."

89. White silk, knotted in the fingers of a pair of white gloves, and so contrived, without suspicion, that playing at primero, at cards, one may, without clogging his memory, keep reckoning of all sixes, sevens, and aces, which he hath discarded.*

90. A most dexterous dicing box, with holes transparent, after the usual fashion, with a device so dexterous, that, with a knock of it against the table, the four good dice are fastened, and it looseneth four false dice, made fit for the purpose.

91. An artificial horse, with saddle and caparisons fit for running at the ring, on which a man being mounted, with his lance in his hand, he can at pleasure make him start, and swiftly to run his career, using the decent posture, with *bon grace*, may take the ring as handsomely, and running as swiftly, as if he rode upon a barb.

92. A screw, made like a water-screw, but the bottom made of iron plate, spade wise, which, at the side of a boat, emptieth the mud of a pond, or raiseth gravel.

93. An engine, whereby one man may take out of the water, a ship of 500 tons, so that it may be calked, trimmed, and repaired, without need of the usual way of stocks, and as easily let it down again.

94. A little engine, portable in one's pocket, which, placed to any door, without any noise, but one crack, openeth any door, or gate.

95. A double cross-bow, neat, handsome, and strong, to shoot two arrows, either together, or one after the other, so immediately, that a deer cannot run two steps, but, if he miss of one arrow, he may be reached with the other, whether the deer run forward, sideward, or start backward.

96. A way to make a sea-bank, so firm and geometrically strong, that a stream can have no power over it; excellent, likewise, to save the pillar of a bridge, being far cheaper and stronger than stone walls.

97. An instrument whereby an ignorant person may take any thing in perspective, as justly, and more, than the skilfullest painter can do, by his eye.

98. An engine, so contrived, that working the *primum mobile* forward or backward, upward or downward, circularly or cornerwise, to and fro, straight, upright, or downright, yet the pretended operation continueth, and advanceth none of the motions above-mentioned, hindering, much less stopping, the other; but unanimously, and with harmony, agreeing, they all augment and contribute strength unto the intended work, and operation; and, therefore, I call this *a semi-omnipotent engine*, and do intend that a model thereof, be buried with me.

99. How to make one pound weight to raise an hundred, as high as one pound falleth, and yet the hundred pound descending, doth what nothing less than one hundred pound can effect.

100. Upon so potent a help as these two last mentioned inventions, a water-work is, by many years experience and labour, so advantageously, by me, contrived, that a child's force bringeth up, an hundred foot high, an incredible quantity of water, even two foot diameter, *so naturally, that the work will not be heard, even into the next*

* "Without foul play."

*room; and with so great ease and geometrical symmetry, that though it work day and night, from one end of the year to the other, it will not require forty shillings reparation to the whole engine, nor hinder one's day work;** and I may boldly call it the most stupendous work in the whole world: not only, with little charge, to drain all sorts of mines, and furnish cities with water, though never so high seated, as well to keep them sweet, running through several streets, and so performing the work of scavengers, as well as furnishing the inhabitants with sufficient water for their private occasions; but likewise supplying rivers, with sufficient to maintain, and make them portable from town to town, and for the bettering of lands all the way it runs; with many more advantageous, and yet greater effects of profit, admiration and consequence. So that, deservedly, I deem this invention to crown my labours, to reward my expenses, and make my thoughts acquiesce in way of further inventions; this making up the whole century, and preventing any further trouble to the reader for the present, meaning to leave to posterity a book, wherein, under each of these heads, the means to put in execution, and visible trial, all, and every of these inventions, with the shape and form of all things belonging to them, shall be printed by brass plates.

*In bonum publicum, et ad majorem Dei gloriam.*†

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* The words marked in italics, not in the MS.

† "Besides many omitted, and some of three sorts willingly not set down, as not fit to be divulged, lest ill use may be made thereof; but to show that such things are also within my knowledge, I will here in mine own cypher set down one of each, not to be concealed when duty and affection obligeth me."

‡ "A *mute* yet perfect discourse, as far distant as eye can reach by day to discern colours."

‖ "Though never so dark."

§ "Multiplying."

¶ "Flowing clock."

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## *The Steam Engine actually constructed and applied to Practical Purposes, by the* Marquis of Worcester.

Mr. Stuart, the author of the Historical and Descriptive History of the Steam Engine, has just published the first part of another work, entitled, "Anecdotes of Steam Engines," which contains, among other novel and interesting matter, the following unexpected evidence, that the Marquis of Worcester did not merely imagine the probability of employing steam, as a moving power, but that he actu-

* *And each of these*—wanting.
‡ "For whole cannon."
§ *Or riband*—wanting.
** *A total*—wanting.
‡‡ Wanting entirely in the MS.
§§ "Primero gloves." The Marquis seems to have been in doubt which he should erase—the brazen head, or the dicing-box.
¶¶ Wanting in the MS.
† Forsacres.
‖ *A whole side of*—wanting.
¶ "A continual watch."
†† "81, 82. Conveyance for letters."
‖‖ "Stamping engine."

ally constructed an engine, on this principle, and applied it, successfully, to the raising of water. It may be recollected, that in his former work, Mr. Stuart, differing from most other writers who have touched on the merits of the Marquis of Worcester, inclined to the opinion, that, nearly all the "inventions," and this of the steam engine in particular, for which the Marquis took credit, and which have made his name so celebrated, existed in fancy only. Subsequent investigation, however, has convinced Mr. S. that he did great injustice to the memory of the Marquis, in this respect; nor can any one, we think, who reads the following extract, have a doubt that, as regards steam power, at least, he has all the merit of being, both the first to conceive the important uses in the arts and manufactures, to which it might be applied, and the first to avail himself, in practice, of the giant strength, which it has superadded to human industry and skill. [*Editor Lond. Mech. Mag.*

"The fact of the Marquis ever having given to the water-commanding engine, any, except a *descriptive existence*, is debatable ground, with authors in mechanics; and, on that account, it may be considered to require some higher authority than mere inference, to decide the point of his having actually constructed an engine.

"The references, it is admitted, are all drawn from the marquis' *own* account of his *own* invention, and which were addressed to the public, in order to induce them to listen to his schemes, and to patronise them. As his pretensions were as high as his imagination was prolific and sanguine, some shade of suspicion may attach to them as being highly coloured, from a less unworthy motive than deception—the gratification of personal vanity. Yet, surely, even this will not be urged, when he is followed into his closet. In his address to the Deity, the phantoms of an overweening conceit could find no place; after his death, the following manuscript prayer was found among his lordship's papers:—

"'The Lord Marquis of Worcester's ejaculatory and extemporary thanksgiving prayer, when first with his *corporal eyes he did see* finished, a perfect trial of his water commanding-engine, delightful and useful, to whomsoever hath, in recommendation, either knowledge, profit, or pleasure.

"'Oh! infinitely omnipotent God, whose mercies are fathomless, and whose knowledge is immense and inexhaustible, next to my creation and redemption, I render thee most humble thanks, from the very bottom of my heart and bowels, for thy vouchsafing me (the meanest in understanding) an insight in so great a secret of nature, beneficial to all mankind, as this my water-commanding engine. Suffer me not to be puffed up, O Lord, by the knowing of it, and many more rare and unheard of, yea, unparalleled inventions, trials, and experiments; but humble my haughty heart, by the true knowledge of mine own ignorant, weak, and unworthy nature, prone to all evil. O, most merciful Father, my creator, most compassionating Son, my redeemer, and holiest of Spirits, the sanctifier, three divine persons and one God, grant me a further concurring grace, with fortitude to take hold of thy goodness, to the end, that whatever I do, unanimously, and

courageously to serve my king and country, to disabuse, rectify, and convert my undeserved, yet wilfully incredulous enemies, to reimburse, thankfully, my creditors, to reimmunerate my benefactors, to reinhearten my distressed family, and with complacence to gratify my suffering and confiding friends, may, void of vanity and self-ends, be only directed to thy honour and glory everlasting.'

"Although, at every period of his life, he seems to have been deeply impressed with the feeling, that progress never was made in any thing by supine wishes, and dilatory efforts, yet unremitting perseverance and assiduous industry, were, in his case, to be of no avail, in stemming the tide of adverse fortune; his wishes were written in sand; and in the prosecution of his philanthropic projects, he was fated to experience, not only the neglect of the public, but the ingratitude of friends, without being convinced of the hopelessness of the attempt at introducing improvements beyond the comprehension, and spirit of the age. As long as hope survived, and that ceased not until he 'was summoned by the angel of death,' he continued to prefer, with vigour, his claims to public attention and patronage.

"After his death,* the marchioness, who seems to have been of a congenial spirit, and to have been actuated by no small share of her husband's enthusiasm, continued her exertions to introduce the water-commanding engine. The zeal with which she prosecuted her scheme, being considered unbecoming her sex, and derogatory to her quality, a Romish priest, who had some influence with her ladyship, was selected, to expostulate, on the impropriety of her conduct; and to convey to her, the wishes, and opinions, of her friends. 'All those,' says the confessor, with no small boldness, 'who wish you well, are grieved, to see your ladyship to be already so much disturbed, and weakened in your judgment, and in danger, to lose the right use of your reason, if you do not timely endeavour to prevent it, by ceasing to go on with such high designs as you are upon; which I declare, on the faith of a priest, to be true. The cause of your present distemper, and of the aforesaid danger, is doubtless, that your thoughts and imaginations, are very much fixed on your title of Plantagenet, and of disposing of yourself for that great dignity, by getting of great sums of money from the king, to pay your deceased lord's debts, and enriching yourself *by the great machine, and the like.* Now, madam, how improper such undertakings are for your ladyship, and how impossible for you to effect them, or any of them, all your friends can tell you, if they please, to discover the truth to you.

"'The effects,' continues the confessor, 'that flow from hence, are many; as the danger of losing your health, and judgment, by such violent application of your fancies, in such high designs, and

* The Marquis died at London, on the 4th of April, 1667, and his remains were carried in much state to Ragland Church, and interred in the family cemetery. Heath examined the vault in 1795, and found there, a plate which had been placed on the coffin, with the following inscription:—

*Illustrissimæ Principis Edwardi Marchionis et Comitis Wigomiæ Comitis de Glamargan, Baronis Herbert de Ragland, et qui obit apud Londini tertio die Aprilis A. Dni. MDCLXVII.*

ambitious desires; the probability of offending the Almighty God, and prejudicing your own soul, thereby; the advantage you may thereby give to those who desire to make a prey of your fortune, and to raise themselves by ruining of you. I confess, that the devil, to make his suggestions the more prevalent, doth make use of some motives that seem plausible; as of paying your lord's debts, of founding monasteries, and the like; and that your ladyship hath the king's favour to carry on these designs.'*

"*The great machine*, appears at this time, to have been in existence; but it were idle to multiply instances, from the Marquis' personal history, or from that of his family. The first, has been thought to savour of enthusiasm, and the latter, might be ascribed, however unjustly, to the praiseworthy, but probably mistaken, gratitude of those, whose affection might urge it as a duty, to be tender of the reputation of an amiable relation, or friend, even in matters, which might be considered as those of his wanderings.

"No such objection can, however, apply to the testimony of an eye-witness, and one who cannot be accused, as speaking from either interest, or friendship. The inspection was made, two years after the death of the noble inventor; the account of it, written in a foreign tongue, lay hidden in a manuscript, deposited in a foreign library, for one hundred and fifty years after the machine itself, probably, ceased to be in existence; and we feel no small gratification, in being the first to give it a place in the history of the steam-engine.

"About the year 1656, Cosmo de Medicis, grand duke of Tuscany, sought respite, and solace, from unhappy family dissentions, by visiting the courts of foreign countries. Cosmo was accompanied by a retinue of men of letters, and artists, for the purpose of recording those circumstances and scenes, which, during his journey, might appear worthy of remembrance. A minute, and circumstantial account of each day's occurrences, was regularly entered into a journal, by the grand duke's secretary. At Cosmo's return to Italy, this Diary was carefully deposited, in the ducal library at Florence.

"From its containing a variety of particulars, respecting persons and places in England, it had become an object of considerable interest to those Englishmen, who were aware of its existence. But it was not, until 1818, that any part of its contents, was disseminated by the press, when that portion of the manuscript volume, which related to England, was translated from the Italian, and published in a quarto volume.

"In that translation, under the date of the 28th of May, 1699, we have the following account of *one* of Lord Worcester's machines:—'His Highness, that he might not lose the day uselessly, went again, after dinner, to the other side of the city, extending his excursion, as far as Vauxhall, beyond the palace of the archbishop of Canterbury, to see an hydraulic machine, invented by my Lord Somerset, Marquis of Worcester. It raises water more than *forty geometrical feet*, by the power of *one man only;* and in a very short space

* The Marchioness died in 1681.

of time, *will draw up four vessels of water, through a tube, or channel, not more than a span in width;* on which account, it is considered to be of greater service to the public, than the *other* machine near Somerset-house.'

"This, therefore, is superior in its operation, to *another machine, by a different mechanic, and applied to the same purpose.*

"Now, in another part of the same Diary, it is stated, that 'his Highness went to see an hydraulic machine, raised upon a wooden tower, in the neighbourhood of Somerset-house, which is used for conveying the water of the river, to the greatest part of the city. It is put in motion by *two* horses, which are continually going round; it not being possible that it should receive its movement from the current of the river, as in many other places, where the rivers never vary in their course: but this is not the case with the Thames, owing to the tide; consequently, the wheels which serve at the ebb, would not do their duty, when the tide returns.'

"Nothing can be more satisfactory, than this last notice; the water in the hydraulic machine at Vauxhall, by the most easy inference, was *not* elevated by a water-wheel, otherwise the grand duke would not have omitted to mention so striking a deviation from that at Somerset-house. The effect was equal to that of another, worked by *two horses;* and a tyro in mechanics would, at first sight, say, that no combination of machinery, could accomplish that work by one man, which it required the power of twelve men to do in another. From all the circumstances, therefore, it appears to us, clear, that this great effect was produced by some sort of a steam-engine; the very identical, 'most stupendous water-commanding engine;' the 'semi-omnipotent engine;' 'the admirable, and most forcible way, to drive up water by fire;' 'the most stupendous water-work, in the whole world,' which he humbly beseeched God to make him humble, as being its discoverer; and which, when he had gone to that 'bourne from whence no traveller returns,' his widow incurred the imputation of insanity, for persisting to carry forwards. And well may we add, in his own language, that in our times, it appears, indeed, 'to have been produced by heavenly inspiration,' and in its power, 'boundless in height, and quantity.'

"From the brevity of the notice in the grand duke's manuscript, it is probable he was ignorant of its principle. It was too novel to be forgotten, had it been imparted to his Highness. But this sort of concealment was the fashion of that time, as it is, in some instances, that of our own. Other coincidences, between the descriptions of Cosmo's journal, and those in the 'Century of Inventions,' are truly remarkable. In both, the height of *forty feet,* is stated to be the elevation to which the water is to be raised; in both, the attendance of *one man* is mentioned; and *four vessels* of water through a tube, or channel, of not more than a span in width, being drawn up, is almost the same choice of words, used in his celebrated sixty-eighth proposition. In fact, had the Marquis been describing the engine himself, from a view of it, in operation, without wishing to describe the principle of its operation, he could scarcely have used other terms, than those used in the journal of Cosmo of Medici.

*On preparing, and Bleaching, Flax and Tow. By* THOS. GILL, ESQ.

WE find in the Philosophical Magazine and Annals of Philosophy, for last month, an article by the Rev. J. B. Emmett, on a method of bleaching, and *preparing* flax; now, as we have given in our work, a number of different articles on this interesting subject, we naturally had our attention excited by the title of the above article: on perusing it, however, so far from finding it to be what it professed, viz. a new method of bleaching, and *preparing* flax, it turned out to be merely *a bleaching, or whitening process*, effected by steeping, or boiling the flax, or tow, in a weak solution of sub-carbonate of soda or potash, in order to extract the colouring matter, resin, &c.; and, after washing the alkali out, finishing the whitening by the use of a little finely powdered charcoal, mixed in a large proportion of water, and with which the flax, or tow, was to be thoroughly incorporated, and suffered to remain steeping, for twenty, or twenty-four hours; and lastly, exposing it, with the charcoal intermingled with it, upon the grass, to the action of air, and light; after which, the remaining charcoal was to be washed out; not a word being said on the *far more important processes of water-rotting*, *braking*, and *hackling*, to which, it was most likely subjected, as usual, by way of *preparing* it for the bleaching, or whitening process, which is all that Mr. Emmett treats upon.

In the present *degraded state* of the linen manufacture, in Ireland, (which must eventually terminate in the ruin of its reputation for making a *durable fabric*, every means being, apparently, taken to insure *its quickly perishing in wear*,) we should gladly hail the adoption of any process which might tend to preserve the naturally strong fibres of flax; but, after the repeated failures of the endeavours to improve the linen manufacture, particularly in the instances of the late Mr. Lee, and of Mr. Salisbury, we must confess that our expectations of such an improvement taking place, are by no means sanguine.

In order, however, to put our readers into possession of the means of preserving the native strength, and beauty, of the vegetable fibres, we shall proceed to quote an article by Gavin Inglis, Esq., originally published in the Philosophical Magazine, in the year 1818, and again by us in our sixth volume, page 328, wherein he says, that he had, in his business of a bleacher, in Dumbartonshire, a few spindles of yarn given him, in the year 1801, to prepare for weaving. There was, in the *sleekness* of the thread, something that attracted his attention. Having soaked it, over night, in warm water, to prepare it for steaming, he was much surprised at the change of colour, and at the quantity of colouring matter dissolved in the water. It was then washed, wrung, and soaked in *weak alkaline ley*, and, laid for steaming, over some brown linens. After steaming the usual time, the covers were taken off, and the yarn was found to have attained a degree of whiteness he had never before observed, under similar circumstances. It was washed in a stream, as long as any colour came from it, and laid on the grass, for two days. That he remembered, well, *the colour*

*was such as to impress him with a strong belief that some great and important discovery might be the result of following up the process this flax had previously gone through, before coming into his hands.* He accordingly traced it, until he found that the flax had been purchased at a Kilmarnock fair, and that it had been pulled before it was *too ripe*, the *greenest pulled* being intended for the *finest purposes;* and that the *whitest flax*, after drying, *had been watered in the burn. They were very particular in watering, and did not allow it to remain so long in the water as he had been led to suppose, from the practice in Dumbartonshire;* nor did they spread it on the grass, after watering, as was likewise the mode in that district, but dried it all from the water, by what is termed *hutting*. He also found that *the white flax, had been uniformly watered in the burn*, and *the dark-coloured, in ponds*, dug where water could be most conveniently obtained; and that when he mentioned a *burn*, he meant *a stream*, so small as to require a dam, being necessary, to receive the water into a temporary pond, to cover the flax. That he conceived *the succession of clean water*, prevented the deposition of *colouring principles* upon the flax, by washing them away, after being extracted from the flax, which he afterwards had an opportunity of proving, *in a pond so constructed, which produced remarkably white flax;* while *the same flax, from several stagnant ponds*, dug in the same ground, filled with water from the same spring, *was very dark in colour.*

The occasion of our republishing this article, arose from our having given, in the preceding number of our work, Vol. VI., page 281, an account of a new method of watering hemp and flax, introduced into Holland by M. Hondt d'Arcy, and which consisted in exposing them, after drying and separating their leaves from them, to the action of a fall of water, of from four to six feet in height, the bundles of hemp or flax being spread over the lower of two wooden gratings, and confined between the other grating, placed upon them. The water was changed every hour, falling through the hemp or flax at each change; during the twenty-four hours; and the process was continued until it was no longer coloured, and which generally required ten or twelve days. The quantity of water applied, and its current, required care, for, if it ran too violently, the substances placed within the gratings might be carried away by it. The regular renewal of the stream of water, produced a uniform colour, and also distributed and preserved, throughout the mass, a proper degree of heat, and it also promoted an equally uniform watering. It was desirable that the sun should not be permitted to shine upon the apparatus.

The flax and hemp, treated by this latter process, *afforded a more flexible, and silky fibre*, than by the ordinary method. And a second advantage was, that a result was obtained in twelve days, which ordinarily required three or four weeks.

Mr. Inglis seems to have previously ascertained the same beneficial results as M. Hondt d'Arcy, from the practice employed in the neighbourhood of Kilmarnock, of *watering flax in a running stream;* and we may add, that the same practice seems to have been adopted in Somersetshire, in the sail-cloth manufacture, in the neighbour-

hood of Yeovil; *the flax being there watered in running streams*, and no doubt with great advantage, in respect to the strength and durability of the sail-cloth; and we may also add, from our own knowledge, to the paper afterwards made of such old sail-cloth.

Mr. Inglis goes on to state, that in *unripe flax*, *he found the colouring matter to be soluble in water;* but this matter, as the flax grew ripe, became less and less soluble, till the water made little or no impression upon it.

In *unripe flax*, the juices of the plant are in a *mucilaginous* state; hence its solubility in water. But if the flax is allowed to stand upon the ground till it has attained a *rusty brown colour*, and the seed is fully ripened, the juices of the plant are then changed, from *mucilage* to *resinous matter*, and, so far as the *resin* is concerned, are certainly *no longer soluble in water*, unless assisted by solvents.

We added, in a note, that Mr. Lee, after treating flax by his patent machinery (the patent for which is now nearly expired,) afterwards merely washed it in warm water, then in a weak soap-ley, and, lastly, exposed it to the light of the sun and air, for a very few hours, upon the grass; and that the specimens in our possession, so treated by him, *are of the most beautiful whiteness*, and have a *silky lustre*, which has actually caused them to be mistaken, by the dealers in silk, for that article. To this we may now add, that Mr. Lee first *braked* the stems of flax, by his improved brake, until it was separated from its woody parts, and could be formed into an endless loop or sliver, by turning one end of the hand of flax, within the other end, having previously passed that end, between a pair of grooved or channeled iron rollers, pressed together by weighted levers, which were driven by machinery, and resembled two long pinions, actuating each other; between the teeth of these rollers, the loop or sliver of flax was kept continually revolving; the *cross fibres* of it, which naturally hold *the longitudinal fibres together*, being broken by the attrition of the rollers, and falling away under them in the form of a delicate, yellow powder. This process was continued a sufficient time, or until the longitudinal fibres appeared to be completely freed from the cross fibres; when they were, as above-mentioned, merely drawn a few times up and down, through warm water, to which they gave a yellowish tinge, and then through a weak soap-ley; they were next opened, and laid upon the grass to bleach, turning them once or twice, and finally finished, by again subjecting them to the action of the rollers, to give them *their beautiful silky whiteness*. We once selected a parcel of *the slenderest stems* from the bundles of flax at Merton Abbey, in Surrey, where Mr. Lee had last established his patent machinery, in the course of the morning of the day we were there, and saw them treated as we have described; and on the following day, they were sent to us perfectly bleached and hackled, and divided into the long flax, and the tow; and form, perhaps, the finest specimens of flax, ever prepared, in this, or any other country, both from the delicacy of the fibres, arising from the slender stems we selected, and from the exquisite *beauty, whiteness and silky glossiness* of the flax; and we shall ever regret the causes which afterwards led

to the abandonment of a concern, which promised to bring the linen manufacture of this country, to a pitch of unexampled excellence.

Our readers will, no doubt, have now arrived at the conclusion, that the Rev. Mr. Emmet has confined his improvements, to the mere *whitening*, and *finishing*, of the flax and tow; and that the previous operations of *steeping*, *braking*, and *hackling*, must all have been applied, before his operations could take place. We know not how flax may be treated in Yorkshire, but if *watered in running streams*, no doubt his whitening process may answer, as it did in the hands of Mr. Inglis, who had adopted that part of his practice, of *soaking the flax in weak alkaline ley*, in the year 1801. With regard to the application of *powdered charcoal*, Mr. Inglis found no difficulty in finishing the whitening of his flax by the ordinary practice of steaming; and Mr. Lee, after treating the flax, by his machinery, merely washed it in warm water, then in a weak soap ley, and laid it upon the grass to bleach and whiten. We well know the powers of charcoal, particularly *animal charcoal*, in bleaching vegetable matters; but, in case the flax had been steeped in *stagnant water*, as is the general *and most offensive practice*, and especially if it had been also covered with the *black mud* lying at the bottoms of the ponds, as is the present practice in Ireland, and whereby the *flax becomes dyed*, we very much question whether any thing short of the *powerful chemical means* actually employed in Ireland, *and by which the quality of the flax so greatly suffers*, could remove that *dye*.

[*Technical Repository.*

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## *On Neutralizing the Magnetism of Watches, and other Time Keepers.*

*By* Mr. Abraham, *of Sheffield.*

From the Transactions of the Society for the encouragement of Arts, &c.

It is, I believe, generally understood by those who have not made the science of magnetism a study, that the fluid is *communicated* to steel bars, and other articles capable of possessing permanent active magnetism, by induction, friction with magnetic bars, &c. &c.

In my opinion, the very contrary is the fact. All ferruginous bodies possess the magnetic fluid, in a latent or inactive state, in proportion to their purity; this fluid may be brought into action, and concentrated, by various means; as position, friction, percussion, attraction, galvanism, electricity, &c. I believe that attraction is the most general cause, of the steel works in time pieces, becoming actively magnetical.

Valuable watches are frequently observed to keep very irregular time, from no visible cause, while the works remain in connexion; and also after they are separated, unless the steel works are tested, by plunging them into fine steel filings. From the minuteness and delicacy of those parts of a time-piece which are manufactured from steel, it has been considered, by those watch-makers with whom I

have conversed on the subject, to be almost an impossibility to deprive them of active magnetism, by any other means than that of heat.

When a balance, or verge, has been exposed to a sufficient heat to distribute the fluid, it becomes unfit for further use, till hardened, and polished; and even then, it is frequently spoiled; therefore, watchmakers prefer, either returning the watch in its magnetic state, or supplying new apparatus, which generally incurs an expense of six or seven shillings in a common watch, and a greater sum in proportion to the value of the works. In attempting to *distribute* (or, according to the general term, *take out*) the magnetism, in any part of the steel works of a watch, with a *very fine magnet*, by *touching* it in a contrary direction, or with a different polarity, it must be complete chance if the experiment succeeds; since the power applied, and the delicacy of the *touch*, must be in proportion to the activity of the magnetism, and the fineness of the part containing it; for, wherever the *finest* magnet last touches any part of a balance, it will leave a small concentration of magnetic power.

With a series of fine, and very delicate magnets, I always failed in *completely* neutralizing the fluid, by the touch. After spending much time without success, I was still determined to surmount the difficulty, if possible. Upon studying the first cause of all my trouble and disappointment, I was led to believe that I, very probably, might destroy the effect, by means similar to those which produced it; and in this I was not disappointed, for the experiment succeeded equal to my expectations. Time-pieces generally become actively magnetical, without being brought into contact with the agent that concentrates the fluid; but, according to the laws of magnetism, a polarity, contrary to that of the magnet presented to it, will always be found in the part rendered magnetical.

This proves that the fluid is put in motion, and concentrated, by *attraction;* present the contrary power in the agent (not in contact) to the same part of the machinery, and it will repel or re-distribute the fluid which was previously attracted, and if it be kept in that position, the least period of time beyond that which is necessary to neutralize the fluid, it will give contrary polarity, to the part subjected to the experiment.

For some time, I found a little difficulty in performing the experiment, satisfactorily, owing to the invisibility of the fluid; but I was relieved from this difficulty, by dipping the apparatus to be experimented upon, into fine steel filings, which rendered the situation of the active magnetism, visible.

Upon presenting a fine magnet to the part clothed with filings, at the distance of, from one inch, to one quarter of an inch, according to the power to be neutralized, it will immediately be perceived whether the polarity of the magnet be of the same kind as that in the apparatus: if so, the filings will gradually fall from the part, as the power becomes neutralized; when all the filings have fallen from the part submitted to experiment, dip it again into the filings, to prove whether it has acquired opposite polarity, by remaining too long in the vicinity of the magnet; if that be the case, present the contrary end of the

magnet at a distance proportionate to the power to be diffused. Very little practice will enable any person to deprive any part of the steel apparatus belonging to the time-piece, of active magnetism, in two or three minutes. I can generally perform the experiment in one minute, however magnetical the balance, or other part may be, that is to be deprived of this concentrated power.

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*On a new method of producing Landscapes, &c. by means of Black-lead dust. By Mr.* GALPIN, *of Charmouth.*

Having, in common with, I believe, all admirers of drawing in black lead pencil, long regretted, that a material of such a natural and pleasing neutral colour, should be confined to the tedious process of producing broad gradations of shade, by means of a laborious repetition of lines or touches, I commenced, about two years ago, a series of experiments, with a view of producing a breadth of touch, and an effect, equal to oil painting, supposing it to be executed in a neutral tint, corresponding with the colour of black-lead; but I found, after indefatigable labour, that the granular separation of that material, when applied to paper, rendered it impossible, although I remained satisfied that it would be superior to any other material for the general purposes of drawing, if this impediment could be removed; and about two months ago, considering that I had heretofore only applied the material in its natural state, I resumed the pursuit, by reducing it to an impalpable powder, and using it with a brush, palette, &c.; the result has been the most complete success; and by a process exceedingly easy and simple, by which, every possible degree of shade can be produced, with the nicest uniformity of tint when necessary, and in less than a twentieth part of the time required in the ordinary manner; with an apparatus too which does not exceed the cost of one shilling, consisting of a small piece of fine muslin, filled with dark black-lead, reduced to fine powder, (and tied up similar to bladder colours used by artists,) which I have called a *shader;* a *palette*, made of thick card-board; and a *brush*, (such as is used by artists, in oil,) of medium size.

*Process.*—The shader, is rubbed two or three times on the palette, near one extremity, by which a small portion of the lead is sifted, as it were, through the muslin; the brush is passed round in the pulverized lead, and on some other part of the palette, to adjust the shade required; the brush is then applied to the paper, with a circulating motion, to produce a sky, or other expanse of shade. A sky which, before this invention, has taken me six or eight hours, I now execute in as many minutes.

The sea is produced by the pith of the common elder, the wood of which is cut away so as to expose the pith to the touch, which, on being applied to the palette, and then to the paper, produces a beautifully soft, and gradual touch.

From the beautifully uniform tint, produced by the brush and pul-

verized lead, I was lead to try the possibility of applying it to useful ornamental purposes, by means of the process of stencilling.

The figures or patterns, are cut out in thin card; one of these being laid on the paper, the brush, previously charged with black-lead, is passed over it with a circular motion, and an impression, or rather a copy of the figure, is the effect. Complicated ornaments, may be produced by the successive application of two, or more figures, on the same ground, or by moving the pattern a little, and then producing a second copy, which will mingle with, and modify, the first. Both these methods, even, might be combined, if a very complicated figure, difficult of imitation, was wanted.

I beg particularly to remark, that my principle of producing skies, can be adopted by any artist, without interfering with his general style of drawing, and is so exceedingly easy, that a novice cannot fail of producing a tolerable effect. I have received several applications from amateurs, (who have presumed I used Indian ink,) to ascertain how I produced my skies so rapidly, but I have not yet communicated my process to any individual, from the hope, that the Society of Arts, will consider my invention an acquisition to the arts, and give it a place in their volume of Transactions; and I beg leave, to add, that it would be highly gratifying to my feelings, to have it first made public, through so distinguished a source; and that I shall feel happy to give the Society any further information on the subject.

P. S. I think I omitted to mention, that the common black-lead, is ground in water, on a stone, in the manner of ordinary paint; then dried before the fire, or in an oven, and again reduced to powder, in a mortar; when it is tied up in muslin, as described in my first communication; in the space of ten minutes, a sufficient quantity may be prepared, to supply the constant application of three months.

The materials used by me, in executing drawings in black-lead, are three brushes, made of badger's hair, similar to those used by painters in oil-colours, and denominated softeners, except being only one-third of the length of ordinary softeners, in the hair; the largest brush, is one inch in diameter, the second, three-eighths, and the smallest, one-eighth of an inch, in diameter. A palette of ordinary size, made of thick card-paper. The pith of the common elder tree, dried naturally; and two small muslin bags, filled with pulverized black-lead.—*Ib.*

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### *On making Elastic Moulds of Glue, for castings in Plaster of Paris. By Mr.* Douglass Fox, *Surgeon.**

Having been much employed in taking casts of anatomical preparations, I frequently met with specimens, principally of hard substances, that did not admit of the moulds hitherto employed, being removed from them. This arose, from any given specimen of such

* From the Transactions of the Society for the encouragement of Arts, Manufactures, and Commerce.

description, having various portions of it with considerable overlaps; that is, there were hollows, or undercut parts, from which no mould could be withdrawn, without its being injured.

Although, in many instances, soft clay, or soft wax, may be used to take impressions, still these, in numberless instances, cannot be removed from the body to be moulded, without being injured, in those parts, which were pressed into the hollows; to overcome these difficulties, it appeared evident, that if an *elastic* substance could be substituted for the soft clay, or wax, the moulds might be withdrawn uninjured, by giving way during the removal, from the undercut parts of any such body, and also, that the moulds would afterwards return to their proper forms again. To effect this, I have made use of glue, which has answered perfectly, employed as follows:—

The body to be moulded, previously oiled, must be secured one inch above the surface of a board, and then surrounded by a wall of clay, about an inch distant from its sides, the clay must also extend rather higher than the contained body; into this, warm melted glue, as thick as possible, so that it will run, is to be poured, so as to completely cover the body to be moulded; the glue is to remain till cold, when it will have set into an *elastic* mass, just such as is required.

Having removed the clay, the glue is to be cut into as many pieces as may be necessary for its removal; either by a sharp pointed knife, or by having threads placed in the requisite situations, on the body to be moulded, which may be drawn away when the glue is set, so as to cut it in any way that may be desired; the use of these threads, need not be more fully explained, as the method is generally known, to persons in the habit of casting.

The portions of the glue mould, having been removed from the original, are to be placed together, and bound round by tape.

In some instances, it is well to run small wooden pegs through the portions of glue, so as to keep them exactly in their proper positions. If the mould is of considerable size, it is better to let it be bound with moderate tightness upon a board, to prevent it bending whilst in use; having done as above described, the plaster of Paris, as in common casting, is to be poured into the mould and left to set.

In many instances, wax may also be cast into glue, if it is not poured in whilst too hot, as the wax cools so rapidly, when applied to the cold glue, that the sharpness of the impression is not injured.

I have stated glue as succeeding well, where an *elastic* mould is alone applicable; but many modifications are admissible. When the moulds are not used soon after being made, treacle should be previously mixed with the glue, (as employed by printers,) to prevent it becoming hard.

The description thus given, is with reference to moulding those bodies, which cannot be so done by any other than an *elastic* mould; but glue moulds will be found greatly to facilitate casting, in many departments, as a mould may frequently be taken by this method in two or three pieces, which would, on any other principle, require many.

Douglass Fox.

The specimens accompanying Mr. Fox's communication, were casts of a deer's horn, and of a calculous concretion, very rough and tubercular, on the surface. The committee, considered it desirable to have before them, also, a specimen of a cast from some soft anatomical preparation, and accordingly directed the secretary to make known their wish to the candidate. This was done, and produced the following additional communication, accompanied by a cast from a fœtus, as described in Mr. Fox's letter.

*Derby, May* 13, 1826.

In compliance with the request of the committee, I have, by means of a glue mould, as before described, made a cast of a deformed fœtus, which has become extremely wrinkled, flaccid, and tender, so that no substance, but a yielding one, could have been applied, and again removed, without injuring the original. By making the mould of an *elastic* or yielding material, this point has been completely obtained.

Even supposing the fœtus could have been moulded as usual, either by plaster of Paris, in many parts, or by pressing clay, or soft wax, upon it, the operation was performed with one-tenth of the trouble by the glue mould; but the original, would not allow of a hard unyielding substance, like plaster of Paris, being removed, without injuring it; nor would it bear the pressure of clay, or soft wax, sufficiently to take an impression. I, therefore, am well convinced, no plan, but an *elastic* mould, could have been employed to procure a cast of the fœtus, without injuring it, as it is in so tender a state.

But it is not in making casts from soft substances, that I consider the *principal* advantage of moulding in glue consists, although, in this department, it is highly advantageous, and will take some preparations, of this kind, which cannot be done by any other means. The great difficulty in casting, is to be able, where it is required, to make a mould which will deliver where there are undercut parts, or hollows, or where there is what is called a dove-tail; now this can only be effected by means of an *elastic* mould, and I have found nothing better for that purpose, than glue, as before described. I am well aware that soft wax has been long employed to form moulds upon hard bodies; but where there are several undercut, or hollow parts, or parts that project, in the subject to be moulded, the wax not being *elastic*, cannot return accurately to its proper position, when removed from the body. More fully to explain this, I have made a cast of a calculus, which could not possibly have been produced by any other mode than that of having an *elastic* mould; soft wax could not have been removed from the undercut parts, without having its form injured; now the glue gives way, whilst being removed, and returns to its former position, or shape, when so removed, which enables the parts to be accurately represented.

I therefore consider the principal advantage of my plan, to consist in the moulds being *elastic*, and consequently capable of removal from hollows, and undercut parts, by giving way, and again returning to their proper forms. This great desideratum in casting, can-

not, in numberless instances, be obtained by any other means. The glue moulds are also, in common instances, much more expeditiously employed than others.

The fœtus having been oiled, was surrounded by two silk threads, previous to the glue being poured upon it, so that when the threads were drawn out, they cut the mould into three pieces; the situations of these divisions, are seen by the seams left upon the preparation. This being done, the elasticity of the glue allowed every part to be removed without the slightest injury. There is no novelty in using thread, as here described.

The mould of the calculus, was merely cut into two parts, which allowed each half to be removed from the stone; they being again placed together, were ready for use, that is, for the plaster to be poured in.—*Ib.*

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## ESSAYS ON BLEACHING.

*By James Rennie, A. M. Lecturer on Philosophy, &c. &c. London.*

### No. III.—CHEMICAL AGENTS USED IN BLEACHING.

### Section IV.—*Soap.*

Very considerable quantities of this article, are used in the several stages of bleaching; chiefly for washing the goods, and, at the conclusion of the other processes, for finishing them, and giving them that gloss and silky softness, in handling, which insures them a ready sale. Like most of the chemical manufactures, soap-making is commonly but little understood by those who are engaged in it, and, consequently, when brought to market, different parcels are very unequal in value. They are commonly ignorant of the proper characteristics of good tallow, which should be as free as possible from sebacic acid; and they are seldom acquainted with the proper method of oxidizing the soap, while boiling; of allowing the alkali a full opportunity of forming a chemical combination with the oil or tallow; and of producing, from potash, a firm consistent soap. Rumford's improvement of boiling by steam, by which a percussion is given to the tallow and the ley, is still less known, (Phil. Mag. XXIX. 283.)

For this manufacture, it is necessary to use a fixed alkali, in a state of causticity. The soap-makers here, take a large quantity of Scotch, or Irish kelp, or Spanish barilla, break it to pieces, grind it coarsely by a horse mill, and when they have mixed it with a sufficient quantity of quicklime, to absorb the carbonic acid, they throw the whole into large wooden, or iron vats, and cover it with water. At a proper time, this liquid, now formed into alkaline ley, is let off into iron receivers below, and the vats are again filled with water, and when impregnated with alkali, this also is let off into the receivers. When a proper proportion of this ley has been prepared, a quantity of Russian, or English, tallow is put into a large iron boiler, and melted with the ley. At first, the tallow appears liquid,

like oil, but during its boiling, it gradually thickens. When most of the alkali of the first portion of ley, has united with the tallow, the weak liquor is pumped from beneath, and fresh leys are added in their stead, which are boiled as before, till the whole acquires a proper consistence, when it is cooled, and prepared for sale. In making yellow soap, which, however, is seldom used in bleaching, one-third, or one-fourth part of rosin is added to the tallow, or to fish oil, which renders the article considerably cheaper. In making soft soap, again, which is much used in the bleachfield, potash, and not soda, is used, as the latter unites too firmly with oil, to be fit for this purpose. Soft soap contains a great proportion of water.

The alkali, renders the oil or tallow, soluble in water, and thus the whole is made capable of uniting with, and removing such extraneous substances as are combined with, or adhere to, the cloth. The tallow itself could never effect this, for though it might combine with such extraneous matters, it could not disengage them; the alkali, again, would of itself act too violently, and could not be handled, with safety, by those employed in washing, for it could not be used to any advantage as a detergent, except in a state of causticity. On the other hand, it is, undoubtedly, the tallow of the soap, which gives goods that softness, and smoothness, which are so requisite to make them saleable: when they are taken from the leys, or the sours, or even after crofting, they always have a hard feel, which makes them appear *hask*, as the Scotch bleachers express it, and much coarser than they really are. To accompany the soap, good soft water, however, is indispensable, and no finishing can be perfect, without this can be had, in abundance.

### SECTION V.—*Sulphuric Acid.*

This is a substance of very great importance in bleaching, upwards of two thousand tons being annually consumed for this purpose, in Britain, and Ireland. It is made by mixing a quantity of sulphur, with an eighth of its weight of dried nitre, for affording a supply of oxygen, and burning the whole, which kindles spontaneously, in very large leaden chambers, according to a plan invented by Dr. Roebuck, and well known. The floor of the leaden chambers, some of which are as large as 96,000 cubic feet, is covered with water, in order to condense the acid, as it is formed during combustion. This quantity of water is indefinite, but when it is found, upon trial, to have been impregnated to a sufficient extent, it is drawn off, or concentrated by boiling. The time for removing it, is either indicated by its assuming a black tinge, or bv examining its specific gravity, which should be about 1.350, or 1.450, although it is commonly allowed to acquire that of 1.560. When the water in the chambers comes to so high a specific gravity, it refuses to absorb the gas, with avidity, and could not be carried, in this way, to a high state of concentration. When in the boiler, again, it is equally necessary to draw it off before it becomes too much concentrated; for the boiling point of sulphuric acid always increases with its specific gravity, and its boiling point is very near to that, at which lead melts; acid, of the specific gravity,

1.848, boiling at 590°; of 1.849, at 605°; and lead melting at 612°. There is, consequently, great danger of the metal giving way, and loss would likewise ensue from the decomposition of the acid, while all the remainder would be much contaminated with lead.—Some manufacturers omit the boiling altogether, in order to avoid contamination with lead, and the bleacher should always prefer acid so manufactured, when it can be procured.

After the process of boiling, it is farther concentrated in glass retorts, where it receives a greater quantity of heat, for drawing off the water, than in the boilers. It is one of the most ponderous fluids with which we are acquainted. It is usually sold of a specific gravity of 1.846, or 1.850, being nearly twice that of distilled water. When pure, it is a transparent and colourless liquid, extremely acid and corrosive, but entirely devoid of smell, and slightly viscid. It is commonly, less, or more, contaminated with lead, and super-sulphate of potash, arising from the mode of manufacturing it. The lead is taken up, in small quantity, from the chambers in which the combustion is carried on, and in the steaming boilers, a sulphate is thus produced, and is subsequently fixed by the process of concentration. This sulphate is often perceptible, in the form of a white powder, at the bottom of the carboys, (sulphuric acid bottles,) when by any accidental cause it is precipitated. The super-sulphate of potash is sometimes fraudulently mixed with the sulphuric acid of commerce, but must always exist in it, in small quantity; for, after the combustion of the sulphur, and nitre, in the leaden chamber, the super-sulphate of potash, is left as a residuum, from the affinity of the potash contained in the nitre, for sulphuric acid, and is consequently taken up, and held in combination. When this adulteration is made on purpose to increase the specific gravity of the acid, and defraud the buyer, the manufacturers add a strong solution of the salt, to the water introduced into the lead chambers, which, in consequence of affinity, readily unites with the acid when it is fermenting. When this adulteration is in considerable proportion, and it is frequently as high as a fifth of the whole, the acid is rendered wholly useless for bleaching. This should put bleachers carefully on their guard, in making purchases.

It may not be improper to mention, although it could scarcely be practised on a large scale, that those impurities can be precipitated by adding distilled water to the adulterated acid, and this, again, may be removed by evaporation. This might, perhaps, be turned to account in examining the quality of acid, about to be purchased. A method has been proposed by Mr. Accum, (Nich. 4to Jour. I. 118,) to detect the several impurities which contaminate sulphuric acid. He directs to dilute a small quantity of the acid, to be tried, with distilled water, and to saturate it with pure vegetable alkali, which will precipitate either copper, iron, or lead, in the form of a more or less dark coloured powder. This is to be separated by the filter, washed with distilled water, and treated with pure ammonia, which, if copper be present, will acquire a blue colour. This blue liquid is to be poured off, and the residuum washed in distilled water, and

dissolved in pure muriatic acid. To ascertain the presence of lead, mix this solution with an equal quantity of water, impregnated with sulphureted hydrogen gas, which, if the acid contain lead, will throw down a black, or dark brown, precipitate. Iron may be detected by prussiate of potash, or tincture of galls. Potash is more difficult to discover: strong ardent spirits will precipitate it in the form of a white powder, if, as is seldom the case, it be not in small quantity. Or a portion of the acid may be saturated with carbonate of ammonia, and a little tartaric acid, added to the solution, when the potash will be indicated under the form of a tartarate.

I believe it is not common for bleachers to be incommoded by the freezing of sulphuric acid, but it is proper that they should be aware of its liability to freeze. The circumstances attending the freezing of this acid, were first distinctly related by Mr. Kier, in the Philosophical Transactions for 1787. Whenever such an accident happens to the manufacturer, it is a proof that it has not been sufficiently concentrated. In winter, then, when a bleacher has much sulphuric acid on hand, he ought to be very circumspect in bringing it to a proper state of concentration. The specific gravity of 1.780, is the middle point of the degree of easy congelation. At 1.790, or 1.770 of specific gravity, it will not freeze, even in melting snow. In severe winters, then, we may infer, that it would not be safe to keep the acid in glass vessels, at any specific gravity between 1.720 and 1.790. Parkes relates an instance, (Chem. Ess. II. 457) in which this property of the acid defeated, most effectually, the fraudulent designs of the manufacturer. Parkes had instructed him in the method of rendering the acid pellucid, without subjecting it to concentration, in the glass retorts. Exulting in the important discovery, he immediately prepared for his customers, a hundred carboys of the requisite transparency, but weak from being much diluted. It happened in winter; a severe frost ensued; the acid was within the limited degrees of freezing, in which case, according to Kier, it freezes even more rapidly than water. It consequently froze, and the carboys, bottle after bottle, would have burst, by expansion, had they not been placed in tepid water.

A bleacher who may be only in his rudiments of chemistry, when he is taught, that sulphuric acid has so strong an affinity for water, as to attract it even from the atmosphere, will be apt to be alarmed lest his acid be spoiled by keeping; but it is only when it is much concentrated, that it attracts much water. It follows the general law of chemical combination, that in proportion as the point of saturation is approached, the attraction is either weakened, or is slower in its action. Besides, it is always used in a much diluted state in bleaching, and, therefore, his alarm can only be well founded, when he is in the act of making a purchase. A bleacher, ignorant of chemistry, would not be likely to give any credit to this doctrine of the acid's absorbing water; but he might be readily convinced, by dipping the bulb of a thermometer in the concentrated acid, which will not probably affect the thermometer; but on withdrawing it, the small portion of acid which adheres to the bulb, will absorb water from the

atmosphere with so much rapidity, particularly in damp weather, that in a few seconds, the mercury will rise several degrees.

There is another circumstance, the knowledge of which, slight as it seems, may sometimes be of use in saving time, namely, that sulphuric acid, when heated, has a remarkable property of retaining its caloric, or of imparting it more slowly to the bodies around it, than other substances generally do. Now the violent heat which is produced on mixing the acid with water, would, in the case of water alone, split any glass vessel into which it might be poured. But in consequence of this property of retaining caloric, it may be poured with perfect safety from the retort into the carboys, at the temperature of 200°; there need be no delay, therefore, in waiting for its cooling, from apprehension of breaking the bottles.

In diluting sulphuric acid for bleaching, care should be taken to add the acid to the water, and not the water to the acid; for if the latter be done, part of the mixture will fly up, and endanger the face of him who may thus act so incautiously. It is best to invert the neck of the carboy, under water, when the acid will leave it, from its superior gravity. The acid should be added gradually, and in successive portions, and be suffered to rest a sufficient time between each addition, that a complete union between the acid and the water may take place; as, even when cold, a mixture of the acid with water, takes several hours to arrive at a maximum of condensation.

It is a great desideratum with bleachers, to have a ready method of ascertaining the real quantity of acid, in that which is diluted. The readiest mode that can be had recourse to, is the tables published in Parkes' Chemical Essays, which I content myself, in the meantime, with merely referring to. One of those tables shows the real quantity of sulphuric acid, at every degree of density.

I may mention here, a remark that may be found to be of importance in constructing extensive bleaching works, namely, that the fumes of sulphuric acid will soon destroy the beams and rafters of the house where the souring process is carried on. Bricks, therefore, are recommended for building such a house. If wood be used, it ought to be well defended by several coatings of the pyroligneous acid. This is gently heated in an iron pot, and put on with a brush. (Parkes, II. 274.)

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*Sulphuret of Lime* was strongly recommended as a detergent, by Mr. Higgins, of Dublin, in a work which he published in 1799, on the Theory and Practice of Bleaching, but it does not seem to have ever come into general use. It was tried also, in several of the bleaching establishments in France, but was laid aside, after the publication of several accurate experiments on it by Citizen Potel of the Academy of Dijon, who proved that it could not be of any use in bleaching, without admixture.—See Phil. Mag. XIV. 199.

## ENGLISH PATENTS.

*Specification of the Patent granted to* CHARLES BAGENALL FLEETWOOD, *of Parliament-street, Dublin, Gent. for a liquid, and composition, for making leather, and other articles, water-proof.* Dated February 28, 1824.

MY new invented liquid and composition for making leather, and other articles, water-proof, consists of a certain compound of resinous, oleaginous, and elastic matters, the proportions of which, and the mode of mixing, I am about to describe. My process is as follows; I dissolve 10 lbs. of caoutchouc, or Indian rubber, in twenty gallons of pure spirits of turpentine, by putting them both into a tin vessel capable of holding at least 35 gallons, 40 perhaps would be as well: the caoutchouc should be cut into pieces, or slices, of about $\frac{1}{16}$th part of an ounce weight, to hasten the solution. I then immerse the vessel into a boiler, previously filled with cold water, and apply the fire so as to produce the boiling of the water, occasionally supplying the waste, caused by evaporation. In this situation it remains until a perfect solution of the caoutchouc, in the spirits of turpentine, is effected; I then dissolve 150 lbs. weight of pure bees-wax in 100 gallons of pure spirits of turpentine, adding thereto 20 lbs. of Burgundy-pitch, and 10 lbs. of gum-frankincense. The solution of these articles, I obtain by the same means as described for dissolving the caoutchouc. To these two matters or solutions, when mixed together, I add, after they are quite cold, 10 gallons of the best copal varnish. The whole of these materials are then to be put together in a large reservoir, where the compound may be diluted by adding 100 gallons of lime-water, pouring in five gallons at a time, and stirring it continually for six or eight hours; which agitation must be repeated whenever any of the composition is taken out of the reservoir, either to be bottled, or casked. In order to colour this composition, when it is required to be rendered black, 20 lbs. weight of the best lamp-black should be mixed up with 20 gallons of the purest turpentine spirits (which 20 gallons should, under these circumstances, have been deducted from the previous mixture); this, when properly blended, is to be added to the composition, but that should be done previous to the introduction of the lime-water. The composition, when thus prepared, is to be laid upon the leather by means of a painting brush, and rubbed into the surface, which will render the leather, after the composition has become dry, impervious to water, and at the same time perfectly soft and pliable. Though I have thus minutely described the comparative proportions of each material, yet I do not mean to confine myself precisely to those respective quantities, nor to the precise mode adopted in mixing and preparing them, but have stated such proportions and such process as the best that I am acquainted with, and which I am, from considerable experience, induced to adopt, and recommend.

*Repert. Pat. Invent.*

*Patent granted to* THOMAS HUGHES, *of Newbury, Berkshire, Miller, for improvements in the method of restoring foul or smutty wheat, and rendering the same fit for use.* Dated May 23, 1826.

THE process used for effecting the purposes mentioned in the title, consists, first, in immersing the smutty wheat, in water; where it is let to lie but a short time, lest the internal part of the grain should imbibe too much moisture. The heavy grain falls to the bottom of the vessel, but that which is decayed, and the smut balls, rise to the surface, from whence they are to be skimmed off, and removed. 2dly. The wet grain is to be put into baskets, or loosely woven bags, to drain. 3dly. When the wheat ceases to drip, it is to be removed to a trough of the following construction, lined with linen, or woollen cloths, and is there to be well rubbed with other cloths of the same description. The trough is about three feet broad, and of a length suitable to the quantity of wheat, which is desired to be operated on, in it, at one time; its bottom is formed of laths or battons, laid together so as to let water pass through; and one of its ends is made to draw up, to facilitate the removal of its contents. Lastly. The grain is to be taken from the trough, and to be spread out in the sun on a clean surface, or on the floor of a moderately heated kiln, until thoroughly dried; when it is to be stored away for consumption.

In some cases, bran, or pollard, may be mixed with the wet wheat to cause it to dry more speedily, which is to be afterwards separated from it by sifting.

The patentee states, that cloths somewhat damp, will remove the moisture from the grain more speedily, than if they were completely dry, and therefore directs, that those used in the foregoing process should be previously dipped in water, and afterwards wrung out so as to discharge as much as possible of what they had imbibed. He also mentions that machinery may be employed in rubbing the wheat dry; and that, though he prefers the trough described, other vessels may be used for the same purpose.—*ib.*

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*To* FRANCIS MELVILLE, *of Argyle street, in the City of Glasgow, Piano-forte maker, for his invention of an improved method of securing that description of small Piano-fortes commonly called Square Piano-fortes, from the injuries to which they are liable from the tension of the strings.*

THE intention of the patentee, is to produce that sort of firm bracing, in the interior of square piano-fortes, that the framing shall not be capable of warping, or being drawn out of its primitive form, by the great tension of the wires. For this purpose, there are firmly fixed by screws, or otherwise, on the rest board or blocks into which the pins are set that stretch the wires or strings, metallic brackets,

with a circular hole in each, to receive the end of a strong metallic rod, which is intended to form a substantial resistance against the tension of the strings, and, by that means, prevent the frame-work from being drawn out of its original shape.

The brackets are simply right-angled pieces of metal, firmly screwed to the rest boards of the instrument; the upright part of each bracket has a circular hole near its top, sufficiently high to be above the wires. The rods are formed with spherical ends, which are let into the circular holes of the brackets, and by their resistance, prevent the wood work from giving way, whatever may be the force with which the wires may be drawn.

Various contrivances have been proposed, for giving stability to the interior of piano-fortes, in order to resist the tension of the wires; the particular novelty therefore, of the present invention, is the peculiar method of attaching the tension rods, by means of spherical ends let into circular holes in the brackets.—Enrolled March, 1825.

[*London Journal of Arts*..

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FOR THE FRANKLIN JOURNAL.

## MECHANICAL JURISPRUDENCE.—No. XVII.

BY PETER A. BROWNE, ESQ.

### *On the Law of Patents for New and Useful Inventions.*

THE REMEDY PROVIDED BY LAW FOR A BREACH OF THE PATENTEE'S PRIVILEGES.

The fifth section of the act of Congress, of 1793, provided, "That if any person shall make, devise, and use, or sell the thing so invented, the exclusive right of which, shall, as aforesaid, have been secured to any person, by patent, without the consent of the patentee, his executors, administrators, or assigns, first obtained in writing, every person so offending, shall forfeit and pay the patentee a sum that shall be, at least, equal to *three* times the price for which the patentee has usually sold, or licensed to other persons, the use of the said invention; which may be recovered in an action on the case founded on this act, in the circuit court of the United States, or any other court having competent jurisdiction."

This section was repealed by the 4th section of the act of Congress of the 17th April, 1800.

The third section of the last mentioned act of Congress, is in these words. "That where any patent shall be, or shall have been granted, pursuant to this, or the abovementioned act, and any person, without the consent of the patentee, his or her executors, administrators, or assigns, first obtained in writing, shall make, devise, use, or sell the thing, whereof the exclusive right is secured to the said patentee, by such patent, such person so offending shall forfeit and pay to the said patentee, his executors, administrators, or assigns, a sum equal to

three times the actual damage sustained by such patentee, his executors, administrators, or assigns, from, or by reason of such offence, which sum shall and may be recovered by action on the case, founded on this and the abovementioned act, in the circuit court of the United States, having jurisdiction thereof."

The action is *on the case*, by the express words of the act of Congress. So, in England, the form of the action is on the case. Godson on Patents, 176. 1 Chit. plead. 142.

THE COURT IN WHICH THE ACTION MUST BE BROUGHT.

Formerly, in England, patent rights were investigated in the court of Star Chamber, 3 Inst. 183. By the second section of the statute of James, it is declared, "that all monopolies, and all such commissions, grants, licenses, charters, letters patent, &c. ought to be, and shall be forever thereafter, examined, heard, tried, and determined, by and according to the common law of the realm, and not otherwise." They are, therefore, now cognizable by the courts of law and equity.

*In the United States, a suit brought for the infringement of a patent right, must be in the circuit court of the United States.*

It has been decided in the case of the Bank of the United States *v.* Deveaux, 5th Cranch, 85, that in cases arising under the laws of the United States, unless jurisdiction be conferred by act of congress, the circuit court of the United States cannot interfere. So, although patent rights depend upon the laws of the United States, yet to justify the jurisdiction of the courts of the United States in sustaining suits by the patentee, it was required, expressly, to recognize his right to sue, in the laws respecting them.

*A state court has no jurisdiction in an action brought for the infringement of a patent right.*

This was decided in Parsons *v.* Barnard, 7 Johnson's N. Y. rep. 144.

It was an action on the case for a breach of the plaintiff's patent for an improvement in rectifying spirits. The defendant pleaded to the jurisdiction, and the plaintiff demurred. The court gave the following opinion. "The act of congress of the 17th April, 1800, (vol. 5, page 88,) declares, 'that whenever any patent right shall be infringed, the party offending, shall forfeit a sum equal to three times the actual damage sustained, which sum shall be recovered by action on the case, founded on the act, &c. *in the circuit court of the United States, having jurisdiction thereof.*'

"The act of Congress, of 21st February, 1793, (vol. 2, p. 203,) also declares, that, in certain cases, when judgment shall be rendered for the defendant, the patent shall be declared void. As the judicial power of the United States extends to all cases in law, and equity, *arising under the laws of the United States*, and as the act of congress, on the subject of patent rights, has declared, that the suit for the infringement of them, shall be brought in the circuit court of the United States, and gives the court power, in such cases, to declare the patent void, the state courts have, of course, *no* jurisdiction in the case; and judgment must be rendered for the defendant.

*The District Courts of the United States have jurisdiction over patent cases, so far as to enquire whether a patent was obtained surreptitiously, or upon false suggestions.* This proceeding, which is directed by the 10th sect. of the act of 1793, will be explained hereafter.

THE FORM OF THE DECLARATION.

In an action in England, for infringing a patent right, the declaration states, that the plaintiff was the true and first inventor; that the letters patent issued, making profert of them; setting them forth; the enrolment of the specification; the using and exercising of the invention by the plaintiff; the infringement by the defendant; and the damage. See 2nd Chitty's Plead. 320.

In the United States, the declaration is of the same tenor, and the plaintiff must support, by proof, all the material allegations in his declaration.

He must prove that he is the inventor; that the invention is new, and useful; that a patent has been granted to him; that his invention produces the required effect; that the defendant has infringed his right; and the amount of damage.

1st, *That he is the inventor.*

This is laid down by Godson, in his Essay on Patents, p. 178; and although he cites no authority, I have no doubt but it is good law. The same thing was decided in the United States, in the case of Evans *v.* Kreemer, 1 Peters' C. C. Rep. 215.

2nd, *That the invention is new and useful.*

In Bovill *v.* Moore, Davis' Patent Cases, 399. Chief Justice Gibbs says, "In point of law, it is necessary that the plaintiff should prove that this is a new, and useful invention, in order to entitle himself to the present action." And in Manton *v.* Manton, same book, 348, 9, the same learned Judge says, "In order to support a right to the exclusive enjoyment of any invention, it is necessary that the party who takes out the patent, should show that the invention is new, that it was unknown to the trade, and to the world, before; that it is not only new, but that it is useful to the public, &c."

Slight evidence, is all that will be required on the above points, in the first instance.

3d, *That a patent has been granted to him.*

By the common law, *a constat*, or *inspeximus*, of the king's letters patent, could not be shown forth in court, but the letters patent themselves, must have been produced; but by statute 3 and 4 Ed. VI. c. 4, explained by statute 13 Eliz. c. 6., "patentees, and persons claiming under them, may make title in pleading, by showing forth an exemplification of the letters patent, as if the letters patent themselves were pleaded and shown forth;" and now they are to be given in evidence in the same manner as if they were pleaded. Godson on Patents 178, and the authorities there cited.

The act of congress of 1793, in the 1st section, declares, "that the letters patent, signed by the President of the United States, and sealed with the seal of the United States, shall be delivered to

the patentee, or his order, and *shall be good and available to the grantee or grantees by force of that act.*"

And in the 3d section, speaking of the description, says, "which description, signed by himself, and attested by two witnesses, shall be filed in the office of the Secretary of State, and certified copies thereof, shall be competent evidence, in all courts, where any matter or thing, touching said patent right, shall come in question."

The letters of the plaintiff, to the Secretary of State, containing applications for a patent and specifications forwarded by him to the secretary's office, certified under the seal of that department, as papers remaining in that office, are evidence for the plaintiff.

Daniel Pettibone sued Henry Derringer, for an alleged infringement of his patent, dated the 12th of February 1814, for a new, and useful improvement in boring musket, pistol, and rifle barrels, by an auger called the spiral, groove, or twisted, screw auger.

The defendant pleaded the general issue, and gave notice that he would give evidence, that the thing secured by patent, was not originally discovered by the plaintiff, but had been in use anterior to the supposed discovery, or that he had surreptitiously obtained a patent, for the discovery of another person.

The plaintiff, in order to maintain this issue on his part, offered in evidence, a certified copy of a letter, from himself, to the Secretary of State, dated 21st of January, 1799, containing a specification of an improvement in boring muskets, &c., certified under the seal of that department, as papers remaining in the office. This evidence was objected to, but was admitted by Washington, Justice.—MS.

4th, *That the invention produces the desired effect.*

This rule depends upon the authority of Mr. Justice Buller, in Turner *v.* Wilson, 1 Term Rep. 606—7. He says, "Wherever the patentee brings an action on his patent, if the novelty, or *effect*, of the invention be disputed, he must show in what the invention consists, and that *he produced the effect proposed by the patent, in the manner specified.*"

5th, *That the defendant has infringed the right.*

The exclusive privilege granted to the patentee, is of *making* and *constructing*, as well as using, and vending. The words are, "and thereupon granting to such petitioner, &c., the full and exclusive right, and liberty, of making, constructing, using, and vending to others to be used, the said invention, or discovery."

It is no breach of the patent, to construct a machine, merely for philosophical experiments, or for the purpose of ascertaining the sufficiency of the machine to produce its desired effects.

This was admitted in Whittemore *v.* Cutter, 1 Gallisson's rep. 429. But, *the making of a patented machine fit for use, and with design to use it for profit, in violation of the patent right, is of itself a breach of the patent right, for which an action lies.*

This was decided in Whittemore *v.* Cutter, 1 Gallisson's Rep. 429. It was an action for the violation of a patent right in a machine for making cotton and wool cards. One objection taken to the direction of the court, was, that the jury were instructed that the making of a

machine fit for use, and with design to use it for profit, was an infringement of the patent right, for which an action was given by the act of congress.

Judge Story observed, "It is now contended by the defendant's counsel, that the making of a machine, is, under no circumstances, an infringement of the patent. The 1st sect. of the act of 1793, expressly gives to the patentee, &c. 'the full and exclusive right and liberty of making, constructing, using, and vending to others to be used,' the invention or discovery. The 5th sect. of the same act gives an action against any person who 'shall make, devise, and use or sell the same. From some doubt, whether the language of the section did not couple the making and using together, to constitute an offence, so that making without using, or using without making, was not an infringement, the legislature saw fit to repeal that section; and by the 3d sect. of the act of 17th April 1800, ch. 25, gave the action against any person who should 'make, devise, use, *or* sell' the invention. We are not called upon to examine the correctness of the original doubt, but the very change in the structure of the sentence, affords a strong presumption, that the legislature intended to make *every one* of the enumerated acts, a substantive ground of action."

"It is argued, however, that the words are to be construed *distributively*, and that 'making' is meant to be applied to the case of a composition of matter, and not to the case of a machine. That it is clear, that the use of certain compositions (as patented pills) could not be an infringement, and unless *making* were so, there would be no remedy, in such cases. We cannot feel the force of this distinction. The word 'making' is equally as applicable to machines, as to compositions of matter; and we see no difficulty in holding, that the using or vending of a patented composition, is a violation of the right of the proprietor."

"It is further argued, that the making of a machine, cannot be an offence, because no action lies, except for *actual damage;* and there can be no actual damages for an infringement by *making* a machine. We are, however, of opinion, that where the law gives an action for a particular act, the doing of that act, imports, *of itself*, a damage to the party. Every violation of a right imports *some* damage, and if none other be proved, the law allows a *nominal* damage."

*If the manufacture made by the defendant be essentially and substantially the same as the one patented, it will be an infringement, though there be a departure from the specification.*

This was decided in Hill *v.* Thompson, 2 B. Moore, 447.

Dallas, J., said, "But it is contended that this is a patent for a combination of processes altogether new, leading to one end; and this being the nature of the alleged discovery, any use made of any of the ingredients, singly, or used in partial combination, omitting some, and making use of all, or some, in proportions essentially different, and yet producing a result equally, if not more beneficial, will constitute an infringement of the patent. It is scarcely necessary here to observe, that a slight departure from the specification for the purpose of invasion only, would of course be a fraud upon the patent;

and therefore the question will be, whether the mode of working, by the defendant, has, or has not, been *essentially* or *substantially different.*"

*The sale of the materials of a patented machine, by a sheriff, on an execution against the owner, is not such a sale as subjects the sheriff to an action for an infringement of the patent right.*

Sawin had a patent for cutting brad nails. The defendant was the sheriff of his county, and having an execution against him, seized and sold the materials of three of the machines. This seizure and sale, was the alleged infringement.

It was contended that, by the 3d section of the act of 17th April, 1800, any person who shall, without the consent of the patentee first obtained in writing, make, devise, use, or *sell* the thing, whereof the exclusive right is secured, shall forfeit, &c.

The court were clearly of opinion that this was not the construction of the act. That a sale of a patented machine, within the prohibition of this clause, must be a sale, not of the materials of a machine, either separate or combined, but of a complete machine, with the right, express or implied, of using the same in the manner secured in the patent. It must be a tortious sale, not for the purpose, merely, of depriving the owner of the materials, but of the use and benefit of his patent. Sawin, &c. *v.* Guild, 1. Gallissons' Rep. 485.

*Whether the acts of the defendant amount to an infringement, is a question of fact for the jury.* 2 H. Black, 480.

*Presumptive evidence of infringement may be received.*

In the case of Huddard *v.* Grimshaw, which was an action for a breach of a patent right to make ropes in a peculiar way, the court admitted evidence that the defendant had requested liberty to use the invention, which was refused, and that he afterwards carried on his business in secret, and refused to permit a friend of the plaintiff's to inspect his ropewalk; and that upon inspecting the ropes made at the defendant's walk, witnesses, well acquainted with the manufacture, believed they were made according to the plaintiff's method.

### THE AMOUNT OF DAMAGES.

*The damages which are to be trebled are compensatory, and not exemplary.*

The words of the act of congress are, "a sum equal to three times the *actual damage* sustained by such patentee," &c. Third section of the act of 1800.

So in Whittemore *v.* Cutter, 1 Gallisson's Rep. 478, the court say, "As to the rule by which the plaintiff's damages are to be estimated, it is clear, by the statute, that only the *actual* damage sustained, can be given. By the term 'actual damages,' in the statute, are meant such damages as the plaintiff can actually prove, and has *in fact* sustained, as contradistinguished from mere imaginary or exemplary damages, which in personal torts, is sometimes given. The statute is highly penal, and the legislature meant to limit the single damages

to the real injury done, as in other cases of violation of personal property, or of incorporeal rights."

*When the defendant has used the machine, &c. the measure of damages should be the value of the use of the machine during the time used.*

This also is decided in Whittemore *v.* Cutter, 1 Gallisson's Rep. 483. The court say, "If the jury are of opinion that an user of the machine is actually proved, the rule of damages should be the value of the use of such machine, during the time of the illegal user."

*In estimating the damages, the jury have no right to take into their consideration the counsel fees.*

This is established by the case of Arcambel *v.* Wiseman, 3 Dallas's Rep. 306. The circuit court of the district of Rhode Island, had decreed, among other things, the payment of 1600 dollars for counsel fees for the court below, and the supreme court of the United States struck this sum out. They said, the general practice of the United States, is in opposition to it; and even if that practice were not strictly correct, in principle, it is entitled to the respect of the court, till it is changed or modified by statute.

This case is cited in the case of Whittemore *v.* Cutter, 1 Gallisson's Rep. 438, and a decision given conformably thereto.

*The jury find the single damages, and the court treble them.* Whittemore *v.* Cutter, 1 Gallisson's Rep. 484.

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## PERKINS'S STEAM ENGINE.

In our last number, we prefaced two extracts from foreign journals, upon the subject of Mr. Perkins's Steam Engine, with some remarks, tending to show we had but little hope, that the high expectations which had been excited respecting this machine, would ever be realized. We have just received a long, and highly interesting letter, from Mr. Perkins, upon the subject of his engine, together with a pamphlet, written by him, "On the Explosion of Steam Boilers," and "On the Economy of using Highly Elastic Steam, Expansively, &c." This pamphlet had not been published in England, at the date of Mr. Perkins's letter. The first part of it, we now present to our readers; the latter part requiring a plate, or cut, must be delayed, until the next month.

We have said, that the letter from Mr. Perkins, is highly interesting, and as we are certain his countrymen will be glad to hear him speak for himself, we publish it entire, with the exception of some free remarks upon individuals, which were intended for the eye of confidential friendship, alone.

Mr. Perkins complains, and we are sure, justly, that a great deal has been published respecting his engine, which, from its absurdity, has tended to bring the machine into disrepute. For ourselves, we confess, that we had ceased to anticipate much from it, and were among those who thought, that Mr. Perkins had attempted impossi-

bilities; to sign our recantation, however, will afford us the most sincere satisfaction: this is one of those tasks from which we shall never shrink, although we instinctively shudder, and incline sideways, when we think of sitting along side a generator, subjected to a pressure of 3000 lbs. to the square inch.

The remarkable fact, discovered by Mr. Perkins, that neither steam, or water, will issue through a fissure in a highly heated generator, is we think in perfect accordance with admitted principles of science, although it is one we should never have anticipated. It is worthy of particular attention, and if it stood alone, would entitle its discoverer to great credit.

The following advertisement, from a London paper, accompanied the communication of Mr. Perkins.

"The High Pressure Safety Steam Engine.—Perkins and Co. are now ready to receive orders for steam engines. They will guarantee the saving of, at least, one half of the fuel, three-fourths of the weight, and three-fourths of the bulk, and will charge but two-thirds the price of the best, London made, condensing engines; reserving the right to one-third of the savings. Orders and communications left at Perkins and Heath's, No. 69, Fleet-street, will be attended to." [*Editor.*

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*Intelligence respecting the* High Pressure, Safety, Steam Engine, *and on various subjects, connected with it; with remarks upon some other engines, which have recently attracted public attention; in a letter to the Editor of the Franklin Journal, from* Jacob Perkins, Esq.

*London, March 8th*, 1827.

*My Dear Friend*,—You must attribute my not having written to you at an earlier date, not to want of inclination, but to a desire of being able to communicate the information which I now give you, namely, that my most sanguine expectations are realized, and to the utmost, in the completion of my *High pressure, safety engine.* This I should have been enabled to say, long since, had it not been for the opposition which I have encountered from avaricious, and interested individuals, by whom my course has been retarded, much more than it has by mechanical difficulties, although these have been enough, in all conscience.

Many of my friends, and some of them very scientific men, have expressed great fears, that I had attempted impossibilities; and were of opinion, that steam engines were so well understood, as to leave little that is new, on this subject, to be discovered. I will ask you, and I will allow no one to be a better judge, if it is not new to generate steam of all elasticities, from the minimum, to the maximum, without the least danger? If it is not new, in the generation of steam, to substitute *pressure*, for *surface*, which I consider the basis of my invention? If it is not new, to have a pressure of 1000 lbs. to the square inch, on one side of the piston, while on the other side of it,

all resistance is taken away by a vacuum, and this produced, without an air-pump, or any more water, than is used, in generating the steam? If it is not new, to have invented a metallic piston, which requires no lubrication, and yet is as tight as the piston of an air-pump? If it is not new, to have applied Sir Humphrey Davy's zinc protectors, to steam cylinders, to prevent oxidation? This, I found, took place in my cylinders, when the engine was not at work, after I found that I could dispense with oil. If it is not new, to dispense with the *eduction valve*, and *eduction pipe*, having no other than a small induction valve, and that, so constructed, as to neutralize the pressure, requiring no oil, and very little power, to open, and close it? If it is not new, to allow the steam to escape, at an opening, 250 times larger, than the steam pipe? All this has been effected, as our friend Lukens can avouch, he having witnessed all these facts, as well as myself. And lastly; if it is not new, to have discovered, that steam may be generated, although in contact with water, at all temperatures, without producing corresponding elasticity?

As soon as my last patent is specified here, I will forward it to you, together with the drawings, not only for your inspection, but with a request, that you will forward them to Washington; as a petition to obtain a patent, will accompany them.

I herewith send you a paper, "On the Explosion of Steam Boilers, &c." This paper I have not yet published here, as it might lead to the discovery of my method of correcting the evil arising from generating surcharged steam, before my patent is specified; but as this will be secure, in a very short time, you are requested, if you approve it, to publish the paper in your interesting journal, as I am anxious for its early appearance in my own country. I have, in confidence, given a copy to Dr. Wollaston, to Mr. Faraday, and to several engineers, whom I could trust, and who all agree, that it assigns the true cause of explosions. I long to see, and to converse with you, and my other really scientific friends in the United States, on this, and other interesting points, connected with my engine.

I have had much interested opposition to contend with, since my residence here; but some of the best men in the country have constantly stood by me, or I must have sunk under the pressure. This government have now given the stamp business, to Perkins and Heath, which we should long since have had, and the country thereby have been saved thousands, but for the intrigues of an individual, who is now *sent to Coventry*.

More than a dozen projectors have attempted to make tubular boilers, since I commenced my experiments, of generating steam by small quantities of water, *under pressure;* but for want of pressure, (which is the novelty I claim in my patent,) they have all failed. M'Curdy from New York, who brought out Hawkins's project, was the first who opposed me. He stated, that I had stolen Hawkins's invention, and gave an air of probability to his assertion, by producing such evidence, from the United States, as he hoped would substantiate it. Yet he was altogether ignorant of my method of generating high steam; and indeed there are not, at this day, ten persons

in the world, who are wholly acquainted with it. M'Curdy took out a patent in this country, and sold to the amount of ten thousand pounds; reserving one-third to himself. He has made three small steam boats; one, large enough to take passengers to Richmond, but no one of them ever steamed more than three miles an hour. The quantity of coal consumed, I could not learn; it must, however, have been too great to answer, had there been no other objection, and they have all been abandoned. Of all the methods yet contrived to generate steam, this was the worst. Had the agent in this business, been considered as the representative of the mechanical talents of his country, it would have been most unfortunate; but such is not the case, as there are now here, four Americans, who stand confessedly pre-eminent, viz. Mr. Lukens of Philadelphia, Mr. Wright of New York, Dr. Church, and Mr. Dyer of Boston.

Brown's vacuum engine, has at length given over, although its death was a very hard one. It was, at last, found, that although, at the beginning of the stroke, the mercury showed a vacuum equal to twenty inches, yet his rarefied air became, towards the end of the stroke, more dense than the atmosphere, and there was, consequently, a great loss from its re-action. I had frequently predicted, that this would be the case, and am apprehensive that Morey's explosive engine will be unavailable, from the same cause.

Brown has certainly shown great ingenuity in the variety of mechanical contrivances which he has invented, in order to overcome the difficulties with which he had to contend; his engine was a beautiful piece of mechanism; its appearance was such as caused it to operate like a charm on his numerous visiters, and many were, consequently, induced to take an interest in, and expend large sums of money, to perfect, an instrument from which they calculated to derive large profits. Is it not astonishing, that men of intelligence should not quickly perceive the difference, between condensible steam, and incondensible air? I have already remarked, that at the beginning of the stroke, the barometer indicated a high degree of exhaustion; it sometimes rose to twenty-four inches, yet his piston, if made to approach the end of his cylinder, as closely as in a well made steam engine, could not, from the density of the contained air, pass the dead point. His first engine, you know, raised water ten or twelve feet high, and this was employed to drive a water wheel; in this arrangement, he did not discover how soon his rarified air lost its power; but when he endeavoured to make his engine work with a piston, he began to experience this unanticipated difficulty. By a very clever contrivance, he, *apparently*, overcame this obstruction, but not without great waste of gas. He attached to his engine, a large separate condenser, in which he burnt his gas, professedly, for the greater convenience of condensation; but it was, in effect, nothing more than lengthening his cylinder, which would have produced the same result in a way much more simple; but to have had a ten foot cylinder, with one foot stroke, would, at once, have torn off the mask, by which the true features of the contrivance were concealed; a catastrophe, which the inventor, very naturally, endeavoured, as long as

possible, to avoid. The consumption of gas was enormous; but as he made his own, or drew it directly from the city pipes, no one but himself could tell, how much he used.

Fascinated with the beauty of the machine, there are many who, yet, declare it to be no failure, and that Brown has been used very ill by the *Gas-engine Company*. One gentleman, who had lost much money in this concern, called on me the other day, and expressed great regret that the gas-engine had not been in my hands; I told him that this would have produced but one advantage, that of having lost less money by the concern, as it was not from want of mechanical skill, that Brown did not succeed, but because the laws of nature were against him; that I was pursuing experiments in accordance with those laws; and that in this consisted the difference in the results to be anticipated from his labours, and from mine. This gentleman expressed much surprise, when I explained to him the difference between condensible steam, and incondensible air.

I am now engaged in building steam artillery, as well as musketry, for the French government. The English government would certainly have adopted this invention, had it not been for the gratuitous and false statements of certain engineers, who declared, that although I was able to make a great display at the public exhibition, made by order of government, yet it was delusive: that I had never made a generator which stood for a week, and that I could not keep up the steam for more than two, or three, minutes at one time. These statements obtained credit, the more readily, as any improvement in the art of war, which could be adopted by other powers, and which would have a tendency to place the weak, upon a par with the strong, appeared likely to benefit other countries, more than England.

The French government have determined to give our new system a fair trial. A series of experiments have been made at Greenwich, which were attended by the French engineers appointed for that purpose, by the duke d'Angouleme, together with one of his aids, and prince Polignac. Their report was so satisfactory to the French government, that a contract was immediately made. An English engineer of the first class, and one who is very much employed by this government, has joined me in the guarantee of the four points, which some of the English engineers have doubted; namely, the perfect safety of the generator, its indestructibility, the ability to keep the steam up, at any required temperature, for any length of time, and its great economy.

The piece of ordnance is to throw sixty balls, of four pounds each, in a minute, with the correctness of the rifled musket, and to a proportionate distance. A musket is also attached to the same generator, for throwing a stream of lead from the bastion of a fort, and is made so far portable as to be capable of being moved from one bastion to another. This musket is to throw from one hundred to one thousand bullets, per minute, as occasion may require, and that for any given length of time. It was an observation made in my hearing, by his grace, the duke of Wellington, that any country de-

fended by this kind of artillery, would never be invaded, and I am very confidently of this opinion.

As soon as this machine is completed, it is to be exhibited to this government, and to several engineers from other powers, who are over here, for that purpose. I have no fears for the result, neither has Mr. Lukens, since he witnessed the experiment made for the French government. He saw the steam gun discharge at the rate of from 500 to 1000 balls per minute, and the steam blowing off at the escape valve, during the whole time; he is equally confident with myself, that the steam may be kept up in such a manner as to discharge a constant stream of balls during the whole day, if required. As regards economy, I am within the truth, when I say that, if the discharges are rapid, one pound of coals will throw as many balls as four pounds of powder.

It has been stated, as an objection to the steam gun, that it would take too long to get up the steam, in case of an attack. To this I answer, that a very small quantity of fire will keep the generators sufficiently heated, when there is no water in them: and that when there is any chance of their being suddenly wanted, they should be kept heated in this way. The heat of the generators would last long enough to give off steam; until the fire is sufficiently increased to furnish a constant supply. For naval purposes, this cannot be an objection, as the steam must always be up. Lord Exmouth, after witnessing a few showers of lead, observed, that he believed the time would come, when a steam gun boat, with two steam guns in her bow, would conquer any line of battle ship; and sir George Cockburn said, that the mischief of it was, it would be to nations what the pistol was to duellists, it would bring all, whether strong or weak, upon a par.

To prove the safety of my engine, I have worked it under a pressure of 1400 lbs. to the square inch, or at a hundred atmospheres, and cut off the steam at one twelfth of the stroke; this was merely to manifest what could be done with perfect security. My usual pressure is 800 lbs. per inch, cutting off at one-eighth, and letting the steam expand to below 100 lbs. per inch. I let off at the dead point, at one flash; the manner of doing this I long to explain to you, but must first get my last patent sealed.

I am informed that our friend, Dr. Hare, thinks I have ventured beyond my depth; in this he is not singular, nor do I wonder that such an idea should prevail, after the publication of so many absurd things respecting my engine; I had no knowledge of these publications, and of course had no control over them. Indeed, I have been extremely cautious about publishing any thing myself, or sanctioning it in others; my determination having been first to complete the *essential* improvements of which I have been in pursuit. I presume that you have seen my last paper on the compression of water, air, &c. Its publication by the Royal Society, has created no small sensation among the philosophers of the old school. The council would not have allowed the reading of it, had not Dr. Wollaston and Sir Humphrey Davy witnessed many of the experiments. I shall soon

publish an experiment with which I think Dr. Hare will be pleased, as it will, if I mistake not, prove practically, what the doctor has so ably attempted to establish theoretically, namely, that caloric is matter. The proof is simple and direct, and I am persuaded that, when you see it, you will think it conclusive. I was led to the discovery of this fact by my experiments upon steam; the results of many of which have been very extraordinary, and quite unexpected. One of the most striking, is the great repellent power of heat. I discovered that a generator, at a certain temperature, although it had a small crack in it, would not emit either water, or steam. This fact I mentioned to a very scientific friend, who questioned its accuracy, and to convince him, I tried the experiment; but he concluded that the expansion of the metal must have closed the fissure. To remove every doubt, I proposed to drill a small hole through the side of the generator, which was accordingly done. After getting the steam up to a proper temperature, I took out the plug, and although we were working the engine at thirty atmospheres, nothing was seen, or heard, to issue from the plug-hole; all was perfectly quiet; I next lowered the temperature, by shutting the damper, and opening the furnace door; a singing from the aperture was soon observable, and when a coal was held before it, rapid combustion ensued; nothing however was yet visible; but as the temperature decreased, the steam became more and more visible, the noise at the same time increasing, until, finally the roar was tremendous, and might have been heard at the distance of half a mile. This was conclusive. I should mention that, at the aperture, the iron was red hot.

My belief is, that water cannot be brought into contact with iron, heated to about 1200°, without a force equal to the maximum pressure of steam, which is equal to about 4000 atmospheres, when water is heated to about 1200°. That pressure, would, I believe, keep it in contact with iron at any degree of heat, and the steam would then be as dense as water. It is very evident that if it would require that force to keep the water in contact, heated as it was at the vent hole, thirty atmospheres must be insufficient to effect this: but the experiment affords some data towards answering the question, at what distance from the heated metal the water remained, when under the pressure of thirty atmospheres? We may safely aver, that it exceeded one-eighth of an inch, as the hole was one quarter of an inch in diameter.

After commencing this letter, I ascertained that my patent was likely in a few days to pass the great seal, and have delayed forwarding it, until I could give you some account of the effect upon the minds of those engineers who were open to conviction, of an experiment performed before them. The patent has been sealed, and the engine has had its power, and economy, tested. The result has been so satisfactory, that an engineer, who employs, at least, 300 hands, has taken orders to make engines, (for I license them out,) with the following guarantee, viz. that of saving half the fuel, and three-fourths of the weight and bulk, with less liability of derangement than ordinary engines. This engineer, whose name is Penn, and who is fre-

quently employed by government, is now making an engine for steam navigation, with a *nine* inch cylinder, and *twenty* inch stroke; he joins me in guaranteeing it to be of sixty horse power. It will not occupy more than *one-sixth* of the room, nor exceed *one-sixth* of the weight, of the ordinary Boulton and Watt's engine, of the same power.

I have sent you the last "London Journal of Arts, &c.," which contains some account of my engine, which is nearly correct as far as it goes. It should, however, have stated, that the piston was eight inches in diameter, that it was a twenty inch, single stroke, engine, a good seventy horse power, and consuming but one-fourth of the coal, of a condensing engine. The weight on the end of the lever was three hundred, instead of one hundred and fifty pounds.

You may, my dear sir, depend upon what I have written; it is the result of actual experiment, and there is no fallacy in it. Having succeeded in making a piston which requires no oil, I am determined to ascertain the limits to which pressure can be carried. I am now making a small engine, strong enough to bear 2000 lbs. per inch, and when done, you shall know the result. Nothing but the piston will limit the power.

The victory, which I have obtained, has been a glorious one for me. For the last three months, many of the engineers had declared me insane, as I had asserted, that I could condense, and produce a vacuum under the piston, without either an air pump, or condensing water; but the tables are now turned, and my triumph, over those who have illiberally assailed me, is complete. By the next packet, you may expect drawings, &c. of my engine; and, I hope, within one short year, to take a seat, with my friend, Dr. Jones, by the side of a generator, sustaining a pressure of 3000 lbs. to the square inch; for this pressure on the generator is required to produce a working power of 2000 lbs. to the square inch, upon the piston.

I have several times mentioned the name of our friend Lukens, who is here, and in pretty good health. He has been introduced to many of the first characters, and is considered as very clever, particularly by one of the greatest philosophers, and best judges of the age. His fame is already high, and is rising, but it must of course require a residence here of some time, for him to be estimated, and remunerated, according to his merits.

This letter has been written, a few lines at a time, as I could catch a spare moment, and sometimes at intervals of several days. You likewise know, that the business of writing is one in which I do not profess to be at home; you will, therefore, I am sure, excuse any inaccuracy, or want of connexion, which it may exhibit, and believe me to be, Yours, truly,

JACOB PERKINS.

*Observations on Perkins's Improved Steam Engine. By the Editor of the London Journal of Arts, &c.*

This important invention, respecting which, such conflicting opinions have been long entertained, appears to be now assuming a shape that will very shortly determine the points of controversy, (viz.) the question of the perfect safety of the engine; its actual power; and the great economy of fuel.

Mr. Perkins's last patent has passed the Great Seal, his recent improvements may, therefore, with safety now be mentioned. The mechanical difficulties against which he has had to contend, in controlling and applying the tremendous power of high pressure steam, has not only absorbed much more time than he anticipated, but has also demanded a greater outlay of money.

The newly constructed engine, to which we have adverted in our preceding number, has been at work for some days, apparently very much to the satisfaction of the few engineers who have seen it. We have been repeatedly present during its performance, and studiously considered its operations, in which we have not been able to detect any fallacy. As, however, we do not mean, at present, to pledge ourselves as to any definite power which the engine is capable of exerting, we shall simply state the manner in which a certain power has been demonstrated in our presence, leaving our readers to draw their own conclusions, from the facts set forth.

The fly-wheel is eight feet in diameter, and the steam, working, as we are informed, at a pressure of twenty-seven atmospheres, caused the piston to perform sixty strokes per minute. The periphery of the fly-wheel being pressed upon by a loaded lever, (called in mechanics,) of the *second order*. The power exerted by the engine at that time, may be known by calculating the amount of force, or friction, acting upon the fly-wheel.

The lever was a wooden bar, about four inches square, bearing upon the periphery of the wheel at the top. The shorter arm of the lever, or distance from the fulcrum to the impinging point, where the pressure acted upon the wheel, was fourteen inches; from thence to the end, that is, the longer arm of the lever was ninety inches. To the extremity of the lever was suspended a weight, making with that of the bar, rather more than one hundred and fifty pounds. From this may be known the actual force overcome, or work done by the engine at that time. By the addition of fifty pounds weight to the end of the lever, the engine laboured, but still worked steadily; by the removal of part of the weight, the speed of the engine became nearly doubled.

The steam, it was said, acted under a pressure of twenty-seven atmospheres, but Mr. P. states, that he usually employs a pressure of fifty-six atmospheres, and that the consumption of coal per hour, is about half a bushel.

Under this pressure of about 800 lbs. upon the inch, the steam is admitted into the working cylinder, and when the piston has de-

scended through one-eighth of its stroke, the ingress of steam is shut off, and the other seven-eighths of the stroke is performed by expansion.

Mr. Perkins's original idea of substituting pressure for surface, in generating steam, (which appears to be the basis of his invention,) has never for a moment been abandoned; and the invention, if satisfactorily established, must certainly be considered as of the utmost importance, particularly in its first feature, *absolute safety*, which could hardly have been contemplated in any other plan of boiler, to the extent which this construction evidently exhibits the capability of effecting. From the mode of constructing the compound generator as now adopted, it becomes a safety valve of itself; for the pressure is divided into so many compartments, that any one of them may explode with impunity, without even disturbing a brick of the furnace. Although in the early part of the invention, many explosions took place, without any attending accident, (which served to show the safety of this method of generating steam, as well as to point out the proper way of constructing the generators,) yet for the last two years, it is said that nothing of the kind has taken place, notwithstanding the steam has been frequently raised to a pressure of above 1500 lbs. to the square inch.

To illustrate the safety of this method of generating steam, let us imagine a few tons of gunpowder to be confined within one compartment, and if ignited, the tremendous effect will be readily anticipated; but let this same quantity of powder be divided into a proper number of compartments, and any one conversant with fire works, would not hesitate to explode it with a match, of not more than a few inches in length. We should not have dwelt so long on this part of the invention, had not the alarm, from the great number of explosions within the last year or two, not only in this country, but in France, and America, created universal terror; particularly in steam-boat travelling; and the danger of explosion would still be more alarming, since it has been recently discovered that the safety valve is of no use, when an explosion takes place from the sudden generation of steam.

We will now mention some of the practical difficulties which Mr. P. has had to contend with. First, the re-action of this highly elastic steam on the eduction side of the piston, occasioned by its density, and expansive property. Second, by the increased friction occasioned by the great pressure on the valves. Third, the carbonization of the lubricating material, whether tallow, oil, or other fat, which was used for the piston and valves. Fourth, the difficulty of preventing the steam from becoming surcharged with caloric, which at times, would be at such an excess, as to melt the joint packings, and heat the steam-pipe red hot.

The first mentioned difficulty is removed by a very novel method, by which the eduction pipe and valve are dispensed with. At the end of the stroke, the metallic piston enters an enlargement at that part of the cylinder, and passes three-quarters of an inch below it, leaving sufficient space for the steam to flash out at the dead point,

into a tube leading to the chimney, at which instant the vacuum valve [?] cioses, and shuts off seven-eighths of the steam, which escapes up the chimney, and the other eighth, under the piston, is easily condensed by a spray of water, which is afterward used for generating the steam. At the next puff, the condensed steam, water, and air, are thrown out, and the heated water runs into the cistern of the pump, from whence it is forced into the generator, dispensing with the complicated and expensive air-pump, as well as with condensing water.

The second difficulty is removed by rendering the employment of an eduction valve unnecessary; for the induction valve requires to be only one thousandth part of the area of the cylinder; the power required therefore to lift it, (even if the valve was not so constructed as to neutralize the pressure,) would be very little.

The third difficulty, which was a very serious one, when the temperature of the steam employed was five hundred pounds upon the inch, is removed by using a metallic piston, made of a peculiar alloy, requiring no lubrication whatever, since it glazes by its working. And as for valves, there is only one little, simple, lifting, induction valve, and that, being destitute of friction, requires, of course, no oil.

Fourth, preventing the steam from becoming surcharged with caloric. This important part of Mr. P.'s invention, we, for certain reasons, are restrained from explaining, at present; it is, however, accomplished, and will be made known when the specification of the last patent is enrolled.

We understand, that Mr. P. has taken some orders for his High-pressure, safety-engines, and guarantees the saving of half the fuel commonly used, for a given power, the weight not to exceed one-third of ordinary condensing engines, and not to occupy more than one-third the space: with absolute security from the dangerous effects of explosion.

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*On the Explosion of Steam Boilers. By* JACOB PERKINS, ESQ.

IT has been generally considered a well established fact, that the caloric of steam, at a given elasticity, is invariably the same, when in contact with water; but this is far from being the case. It may be, and often is, so generated as to indicate very high degrees of temperature without a corresponding increase of power; so as evidently to prove, that temperature, alone, cannot be relied on as a measure of the elastic power of steam. Many experimentalists have thus undoubtedly been led into error, especially in reference to high temperatures. If any part of the boiler which contains the steam be suffered to become of a higher temperature than the water contained in it, from want of a sufficient supply, the steam will readily receive an excess of caloric, and become surcharged with it, without acquiring proportional elasticity. In some recent experiments, I have heated steam to a temperature that would have given all the power

that the highest steam is capable of exerting, which would have been 56,000 pounds to the square inch, if it had had its full quantum of water; yet the indicator showed a pressure of less than five atmospheres. Having satisfied myself, by repeated experiments, as to the certainty of this curious fact, the thought struck me, that if heated water were suddenly injected into the superheated steam, the effect would instantly be, the formation of highly elastic steam; the strength of which would depend upon the temperature, and quantity, of the surcharged steam, and of the water injected. To ascertain the truth of this theory, I made the following experiments.

A generator was filled with water, and heated to about 500 degrees, and, consequently, exerted a force of about 50 atmospheres; but the pressure valve being loaded to about 60 atmospheres, it prevented the water from expanding into steam. The receiver, which was destitute of both water and steam, was heated to about 1200 degrees: a small quantity of water was injected into the generator, by the forcing pump, which forced out, from under the pressure valve, into the receiver, a corresponding quantity of heated water, and this instantly flashed into steam; which from its having ignited the hemp cord, that covered the steam-pipe, ten feet from the generator, must have been at a temperature of, at least, 800 degrees, which would be equal to about 800 atmospheres; but, from want of water, to give it its necessary density, the indicator showed a pressure of about five atmospheres. Whether the pressure of the steam, which was rushing through the steam-pipe, was at 5 or 100, or more atmospheres, the steam-pipe kept up at the high temperature before mentioned; which I attributed to the steam being surcharged with caloric. The pump was now made to inject a much larger quantity of heated water, and the indicator showed a pressure of from 50 to 80 atmospheres; the throttle valve being partly opened, it soon expanded, to the former pressure of about 5 atmospheres. The water was then injected again and again, and the indicator was observed to oscillate at each stroke of the pump, from 5. to between 40, and 100, atmospheres, according to the quantity of water injected; clearly showing that at this reduced pressure, there was a great redundancy of heat, with little elastic force. It soon occurred to me, that to this might be traced the true cause of the tremendous explosions, that suddenly take place, in low, as well as in high, pressure boilers.

There are many instances, where, immediately before one of these terrific explosions had taken place, the engine laboured; showing evidently a decrease of power in the engine. To illustrate the theory of sudden explosions, let us suppose the feed pipe, or pump, to be choked; in this case, the water would soon sink below some parts of the boiler, which should be constantly covered by it, thus causing them to become heated to a much higher temperature than the water. The steam now being in contact with the heated metal, readily takes up the heat, and becomes surcharged with it.* Since caloric will

* Practical engineers have frequently witnessed the destruction of the packing of pistons, by their becoming charred, although the steam issuing was in contact with the water, the temperature of which did not exceed 230 degrees.

not *descend* in water, it cannot be taken up by the water which is below it. The steam thus surcharged, will heat the upper surface of the boiler, in some cases, *red-hot*,* and will ignite coals, or any other combustible matter which may be in contact with it. If the water which is kept below the surcharged steam, by the pressure of it, should, by any circumstance, be made to take up the excess of caloric in the steam, as well as that from the upper part of the boiler, which has become heated above the temperature of the water, in consequence of the water having been allowed to get too low, it will instantly become highly elastic steam, and an explosion cannot be prevented by any safety valve hitherto used. To show how the water may be suddenly brought in contact with the over-heated parts of the boiler, as well as with the surcharged steam, it will be necessary to state the following facts.

As long as water is not heated above 212 degrees, it will simply boil, and give off atmospheric steam, without the water having any tendency to rise with it; but, as it becomes more and more elevated in temperature, its disposition to rise with the steam becomes more and more apparent. As the steam presses on the surface of the water, in the same ratio as the water increases in temperature, it only boils without rising, as when at atmospheric pressure; but if the steam should be drawn off faster than it is generated, this artificial pressure would be taken off, and the water would rise with the steam in proportion to the suddenness and rapidity of its escape. The water and steam in this mixed state, thus filling every part of the boiler, the excess of caloric in the surcharged steam, as well as the extra heat from the boiler, will be instantly taken up by the water which rises with the steam, by which means the steam becomes sufficiently dense (or powerful) to produce the fatal effects too often experienced, not only from high, but from low pressure boilers. If, for instance, the water (as has before been noticed) should be suffered to get be-

It is very evident, that this steam was surcharged with heat, and was much above the temperature of the water upon which it was reposing, and in a suitable state to produce explosion, had the water been allowed to rise with the steam, by drawing it off faster than it was generated.

* Mr. Moyle, a practical engineer from Cornwall, gave me the following interesting fact:

On going into his boiler room, he observed a ladder, the foot of which rested on the top of his boiler, to be in flames: he instantly ascertained that the top of the boiler, from some cause which he was then unable to determine, had become *red-hot;* with all possible promptitude he ordered the fire to be quenched, which, probably, saved his premises, and, perhaps, his life. Mr. Moyle found, upon examining the boiler, when cold, that very little water remained in it.

A stronger case still, was that of an explosion at the iron foundry at Pittsburgh, North America. As is the practice in North America, a high pressure engine, of sixty or eighty horse power, was supplied with steam from three separate cylindrical boilers, each being thirty inches diameter, and eighteen feet long. One of these boilers had for some time been observed to be getting red-hot; but, as the other two supplied a sufficiency of steam for the work then doing, it was disregarded, until it exploded. The main body of the boiler separated from one of its ends, at an angle of 45 degrees, and passed off like a rocket through the roof of the building, and landed about 600 feet from it.

low any part of the boiler, which is exposed to the fire, the steam will soon become surcharged with heat. If a boiler, thus circumstanced, should have the weight taken from the safety valve,* or a small rent be effected in the boiler from its giving way by the pressure of the steam, an explosion will be sure to follow. A remedy for this kind of explosion, which appears to be the only serious one, is that of not allowing the water to subside below any part of the boiler which is exposed to the fire. In case the water should settle, it may be known by having a tube, with its upper end trumpet-mouthed, and its lower end fixed in the boiler, entering a few inches below the surface of the water; then, as soon as it subsides sufficiently to allow the steam to blow off, the blast will give warning that no time should be lost in supplying water, or checking the fire.† When highly surcharged steam is rushing from the safety valve, or any other aperture, it may be known by its perfect invisibility, even in the coldest day, nor can it be seen at any distance from the valve or cock; it is, however, condensible; as may be seen by holding any cold substance in its range.

* It was stated in evidence at the coroner's inquest taken at the Humber, in the case of an explosion on board of the Graham steam boat, that just before the explosion took place, twenty pounds were taken off the safety valve. Now, if the steam in this boiler had been properly generated, the relief given to the safety valve, could not have produced explosion; but if the water had got low in the boiler, (as was probably the case,) and the steam surcharged with heat, the ready way to produce explosion, was to allow the steam to escape faster than it was generating, when kept in the lower part of the boiler by the pressure of the confined steam.

Several instances have occurred when there has been sufficient warning, by the rushing of the steam from a rent or fracture, for the bystanders to escape from injury before the explosion took place. There has been, at least, one case, where the boiler was raised from its bed, into the air, by the force of the steam issuing from the rent, (upon the principle of the rocket,) before the water had sufficiently expanded by the removal of the steam, caused by the rent or fracture, to take up the heat of the boiler, and the surcharged steam; when an explosion took place after the boiler had been raised many feet in the atmosphere, and it separated with a very great report, one part rising still higher, while the other was dashed with great force on the ground. It is, I believe, a fact, that more persons have been killed by *low*, than by high, pressure boilers.

It is but about twelve months, since sixteen persons were killed by the bursting of a low pressure boiler, in Flintshire. High pressure boilers have since been substituted. Some of the most dreadful accidents from explosions which have taken place in America, have occurred from low pressure boilers.

‡ This will apply only to low pressure boilers, on account of the height of the column which would be required to balance the pressure of the steam. The high pressure engines, as used in Cornwall, would require a column, varying from 60 to 120 feet; and the new high pressure safety engine, now coming before the public, would require a column more than four times as high as St. Paul's cross, to balance the steam.

FOR THE FRANKLIN JOURNAL.

## *Facts, and Observations, on the bursting of the boilers of Steam Engines.* *By* ERSKINE HAZARD, Esq., *Civil Engineer.**

THE frequency of disasters arising from the bursting of boilers, in steam boats, both with high, and low, pressure engines, makes it the imperious duty of all those who have given particular attention to the subject, to make public any ideas which may throw light on the cause of them, as they may thereby aid in preventing their repetition. With this view, I take the liberty of sending you the following explanation, which was given to me by our countryman Perkins. He builds his theory, on the ground that the power of steam does not depend upon *temperature* alone, but principally upon the *quantity* of *water* that is contained in a given bulk of it: in other words, that its power is derived from its *compression*. This corresponds with the experience of the late Col. Alexander Anderson, who gave me the same theory many years since, and at the same time informed me, that when distilling by steam, he uniformly found *the quantity of liquor* produced in a given time, to be in exact proportion to *the pressure within* his still. He hence concluded, that atmospheric steam, confined in any vessel, in such a manner that it could not get an additional supply of water, might be *heated red hot*, without bursting the vessel, or increasing its power. Perkins states, that he has completely realized this idea, in his experiments. He also mentions a fact communicated to him by Mr. Williams, principal manager of the Dublin and Liverpool steam company, which was this. The people on board the boat were alarmed, while on their voyage, by the smell of *pine* smoke, and concluded that the boat must be on fire; but upon searching, they found a piece of pine wood on the top of one of the boilers, which was nearly burnt to a coal; it was in such a situation, that no fire could have communicated with it, except through the top of the boiler. The engine at the time, was working with steam only a few pounds above the atmospheric pressure. Upon mentioning this circumstance to the captain of one of our Delaware steam boats, he informed me, that the leaden joints of his steam pipe were once melted, when the steam guage indicated only the pressure at which they usually worked. In both these cases, the water was so low in the boilers, that the heat was communicated to the steam through a portion of the boiler which had no water in contact with it, and which, of course, became red hot, while the steam could not part with its heat, *downwards*, to the water.

The *repellent power of heat*, is the proximate cause of explosion, according to Perkins's theory. This was one of the principal obsta-

* This communication from Mr. Hazard, was received a month earlier, than that from Mr. Perkins, although too late for insertion in our number for May. The facts and reasoning which it contains, are intended to enforce, and confirm, the theory offered by Mr. Perkins; we, however, do not apprehend that our readers will object to some repetition, on a subject so truly of *vital* importance. [EDITOR.

cles he met with in the progress of his experiments on high steam. In his tubular generators, he found it impossible to keep the water *in contact* with the metal, when a great heat was applied, until he adopted the expedient of the pressure valve, loaded with five atmospheres more than the pressure of the steam. The water was, as it were, *wire-drawn*, or passed through the *centre* of the tubes in a fine thread, being repelled by the heat of the sides, which increased to redness, and finally destroyed the tubes. To show this repellent power of heat, he made a hole of $\frac{1}{4}$ of an inch diameter in one of his generators, and adapted a plug to it, which was removed when that part of the tube became red hot; no steam, or water, escaped from it, notwithstanding the steam-guage indicated a very high pressure: a wire was introduced into the hole, to ascertain that it was free. The generator was then suffered to cool to a black heat, when the steam commenced issuing from the hole with great violence. Another experiment was to heat two cast iron bowls of equal dimensions, the one black, the other red hot, and then to pour equal quantities of water into both: the cooler bowl uniformly evaporated the water first. I have frequently noticed very hot pieces of iron, when thrown into a blacksmith's slack-trough, lie red hot for some time under the water, apparently surrounded by an atmosphere of heat, without throwing any steam to the surface. This will never be the case if the *tongs be plunged* into the water with the hot iron; as their heat, in some part, is only sufficient to raise steam, and not sufficient to prevent the water from coming in contact with them, and through them, with the whole mass, successively. From the above facts, Perkins's explanation of the bursting of boilers, will, I think, appear very plausible: it is this; that the water is suffered to get so low as to bring a portion of the boiler, not covered with water, in contact with the fire; this becomes red hot, and imparts its heat to the steam; the redness gradually extends itself below the water, which is at length repelled from the boiler, and thrown up among the *hot steam*, (like a pot suddenly boiling over,) which surcharged steam, immediately imparting its *excessive* heat to the water, forms steam of the greatest power, and occasions the disastrous explosions.

In the late accident on board the Oliver Ellsworth, it seems to be impracticable to ascertain what was the state of the water in the boiler; but supposing it to have been at the proper height, may not the motion of the vessel, from a head sea, have left portions of the boiler exposed to the fire, for a length of time sufficient to make them red-hot, and the above theory be thus rendered perfectly applicable? Should this be the fact, it appears to me, an additional security would be obtained, by having the boiler divided by partitions, which, though not tight enough to prevent a regular communication from the supply-pump, and steam-pipe, to every part of the boiler, would still be sufficiently so to prevent the water from rushing, in a body, from one extremity to the other, thus leaving portions of the boiler unprotected from the fire. These partitions might be constructed of rough boards, in such a manner that they could be removed when

the boiler required cleaning, and would rather favour, than retard, the process of making steam.

The bursting of the boiler of the Ætna, was attributed to the supply-pipe being choked. To this then, the theory is perfectly applicable. Your obedient servant,

ERSKINE HAZARD.

Philadelphia, April 16th, 1827.

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## FRANKLIN INSTITUTE.

### THIRTEENTH QUARTERLY REPORT.

*At a meeting of the Franklin Institute, held at their Hall, on the 19th of April, 1827, the following Report of the Board of Managers was read, and accepted.*

PHILADELPHIA, APRIL 19, 1827.

In accordance with the laws of the Institution, the Board of Managers of the Franklin Institute of the State of Pennsylvania now present to the general meeting, their thirteenth Quarterly Report.

Since the period of the last quarterly report, the several courses of lectures, on Mechanics, Chemistry, and the Natural History of the Earth and of Man, have terminated, having been continued regularly throughout the season. Besides the subjects included in these regular lectures, several others have been treated, by members who have volunteered for that purpose. Mr. Jno. Finch, a gentleman distinguished for his knowledge in Geology and Mineralogy, has recently commenced a series of lectures upon those subjects, to which the members of the Institute have free admission.

At the commencement of the lecturing season, the courses were all very well attended, but as they proceeded, much inconvenience was experienced from the indecorous conduct of a considerable number of boys, whose only object in attending must have been amusement, as many of them were wholly disinclined, and others too young, to derive benefit from the lectures. Owing to this circumstance, a large proportion of the senior members declined attending, as the courses advanced. The Board have been extremely desirous of extending to the younger classes of the community, the advantages offered by the lectures delivered in the Institute; but after fairly trying the experiment, they will find themselves compelled to restrict their attendance, within much narrower bounds than heretofore.

The High School of the Institute continues with its full complement of pupils; and its discipline, and course of instruction, are in a state of progressive improvement. An examination of the scholars was held before the committee of Instruction, in the beginning of this month, which was found very satisfactory. It is intended to hold a public, and thorough, examination at the close of the session in July.

Since the last meeting of the Institute, a final settlement has been made with the contractors for the Hall. Some additions to the build-

ing are yet required; such as iron railing in the front and along the sides, which were not included in the contract; these will be completed, as soon as the state of the funds will justify it.

It has been determined to place iron pillars under the girders in the lecture, and court rooms; for although no danger is apprehended of their breaking, they have not been found to possess sufficient stiffness for rooms so large. There was a novelty in the mode of trussing these girders, respecting the efficiency of which there was, in the first instance, considerable contrariety of opinion; they were, however, after much discussion, finally adopted, but it must be confessed that the experiment has not been found a successful one. The necessary alterations will not be attended with any considerable expense or inconvenience.

The Treasurer's report, which is herewith presented, exhibits a balance in hand amounting to $143 75.

By order of the Board of Managers.

CLEMENT C. BIDDLE, *Chairman.*

THOS. P. JONES, *Secretary.*

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*Report of the Committee of Inventions, of the Franklin Institute, on the plan of a Floating Dry Dock, invented by* EDWARD CLARK, *Civil Engineer.*

The Committee of Inventions of the Franklin Institute who have had under examination the plan of a Floating Dry Dock invented by Edward Clark, civil engineer, of New-York, report—

That this dock is proposed to be constructed by forming a float of timber, which is intended to constitute the bottom of the structure, and which by its buoyancy, is to support a vessel, within the dock, with its keel above the surface of the water; to attain this end, the float is to be made in the form, of a large hollow box, formed of strong logs, firmly joined together, and calked so as to render it water tight; the capacity of the hollow part must be such that when exhausted of water, by means of pumps, it shall be sufficiently buoyant to sustain itself, with its load. The Committee annex to this report a drawing of the proposed dock, with its appurtenances, which, with the accompanying references, will be sufficiently explanatory of the design.

Whilst the Committee award to the inventor much credit for the ingenuity which he has displayed, and are convinced that it is practicable to construct a dock upon this plan, and that the piers, supports, and braces, are well calculated to give all the stability to the structure of which it is susceptible, they are of opinion that great practical difficulties would present themselves in the construction and use of this dock, as well as in others which have been projected with similar views.

The Committee do not deem it necessary to enter into calculations to estimate the dimensions of the float requisite for a large vessel, the size and weight of the materials to be employed, and the capacity of its chamber; the data for these calculations being within

the reach of every one, conversant with the subject of engineering. The main objection to docks of this description, made sufficiently capacious for large vessels, and for the operations to be carried on in repairing them, is the unequal pressure to which their bottoms must be subjected, by the weight of the vessel upon them, and the upward pressure of the water. They are aware that by judicious shoring much of the weight of a vessel may be distributed over the bottom, this however, although it would lessen, would not remove the objection.

Ships, although constructed in a shape, and braced in a manner calculated to render them stable, undergo, in nearly every instance, a change of form, after they are launched; to this change of form, the float in question, would be much more liable, in as much as its flat surfaces are less calculated to resist the effects of the pressure to which they are to be subjected.*

In situations where marine rail-ways can be erected, the Committee believe them to be preferable to a floating dock, howsoever well, the latter may be constructed; there are, however, many places where the soil and other circumstances would render it extremely difficult, if not impossible, to construct a rail-way: in such situations, and when the vessels to be repaired are not of the larger class, the floating dock may be found advantageous; and they believe that under such circumstances, the plan before them presents considerable advantages above those floating docks from which the water must be excluded by flood gates.

PHILADELPHIA, April 4th, 1824.

Attest, THOMAS P. JONES, *Sec'y.*

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*Description of the Floating Dry Dock, the plan of which has been submitted to the Franklin Institute; with an engraving, and explanatory references. By* EDWARD CLARK, Esq.

For sometime before, and even after I entered into engagements with the New York Dry Dock Company, in the spring of 1825, my attention was drawn to the construction of a floating dry dock. The plans proposed by Commodore Barron and Capt. Caldwell, as contained in the Franklin Journal for Jan. 1827, occurred to me, and

* The report of the Committee of Inventions, on my Floating Dock, has been shown to a very respectable ship builder of this city, who concurs in opinion, with the committee of the Franklin Institute, in respect to the difficulties and objections to the practical use of this plan, provided the ordinary mode of building be resorted to in the construction of the float; but he, nevertheless, thinks, that by increasing the depth of the frame, so as to introduce an extra quantity of timber into it, and securing it well with iron, a dock may be constructed at a reasonable expense, capable of sustaining our largest trading ships, without perceptibly yielding to the inequality of pressure which would be produced by any change of form which the superincumbent vessel had undergone; and, consequently, that such vessel would as readily resume its original form on the deck of such a float, as on the common rail-way. And further, if such should not be the case, by resorting to the ordinary mode of wedging, the keel of the vessel may be made to conform to the required line.

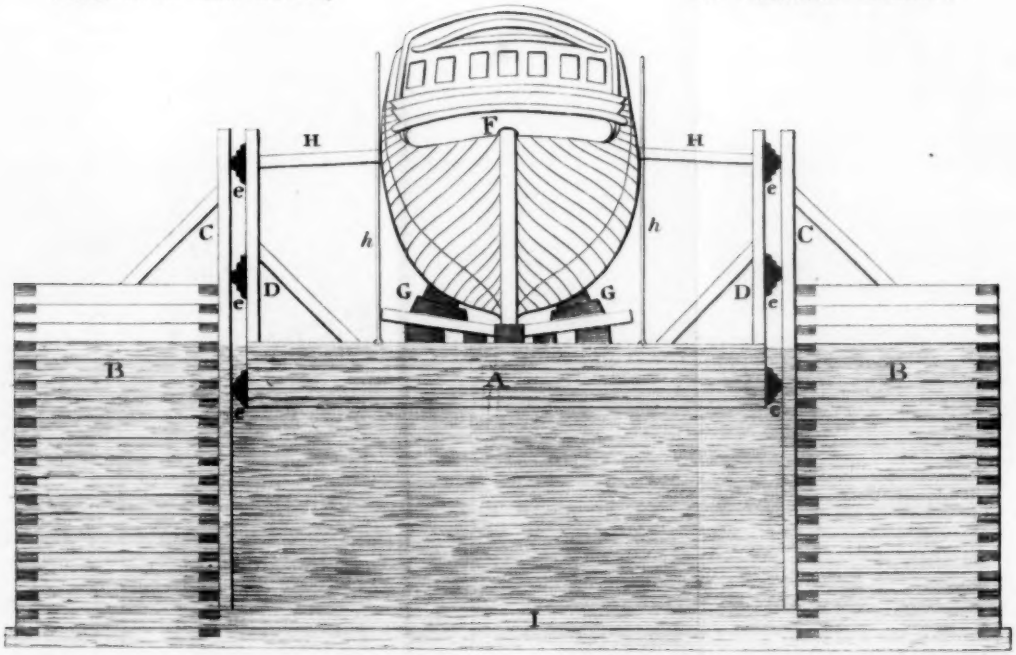
New York, April 25th, 1827. EDWARD CLARK.

were severally considered, at least in their general principles, if not in detail; and I went so far as to examine a site belonging to Saml. Leggett, esq. on Long Island, with a view of building one conformably to the latter plan. But on more mature reflection I abandoned them both; that of the Commodore, on the grounds 1st, of the unequal quantity of water, comparatively speaking, that it would be requisite to displace to accommodate vessels of different capacities; for it is evident that the dock must be freed of water, every time a vessel is admitted, in order to allow of its thorough repair, and for convenience to the workmen; and vessels of the same draught, often vary from one fourth, to one half, in the quantity of water they displace, owing to their difference of model. 2d, of the loss of buoyancy occasioned by elevating the hollow sides of the dock above the water line, or their bearing on the water, and consequently the loss of power, applied to create this buoyancy, and also to sustain the materials of which the sides of the dock may be constructed, above water, and 3d, because such docks would be dark and wet, and not sufficiently commodious for the repair of ships, &c. That of Captain Caldwell, was objected to, first, on account of the great expense required for its construction, and secondly, from the remoteness of the site from the city.

As a substitute for these contrivances, I proposed to the directors of the company, the plan of which, the enclosed print presents one view, viz: the stern of a vessel resting on a floating dock. A. representing the float. B. B. piers, forming a recess to steady and secure the float. C. C. perpendicular supports and braces, appended firmly to the piers; and D. D. also supports and braces appended firmly to the float, so as to allow, by means of the rollers e. e. e. e. of the easy and steady ascent and descent of the float, conformably to the motion of the tides and waves, and also of sinking and raising the float in the same place. F. vessel's stern. G. G. bilge blockings. H. H. braces; all for supporting, and steadying, the vessel in an upright position. I. timbers, framed into the piers, forming a bed for the support of the float, while sunk. The float A. is supplied with valves and pumps, not represented in the print; and if it be required to float the vessel F. nothing more is necessary but to open the valves, when the float, being previously ballasted, will fill with water, and sink to its bed. The vessel F. being now removed, and another made to occupy its place, by means of guides, the valves are to be closed, and the pumps put in motion; and when a quantity of water has been displaced from the float equivalent to the weight of the incumbent vessel, she will be elevated entirely above the water, without loss of power. and placed in a most favourable situation to undergo repairs. A float of this description, for use in sea water, would require to be coppered externally, and occasionally to be filled with some other saline fluid, or with fresh water, to preserve it from the worms.

After reflecting on the various plans presented, and consulting eminent engineers, the borad of directors concluded to adopt the marine rail ways of Morton's invention, which have been completed

*FLOATING DRY DOCK,* *BY EDWARD CLARK.*




*W. Hooker Engraver & Printer N York 1827.*

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with some slight, or immaterial variations; but at the extravagant expense of between seventy and eighty thousand dollars. This company are now building others on the same plan; they will not probably cost half as much. But however cheap they may be built, where the rise and fall of the tide is trifling, they will always be found too expensive, excepting in large cities.

The plan I now offer for consideration and report, will, it appears to me, generally, answer a better purpose, than rail-ways, and perhaps, than the docks of Commodore Barron, and Captain Caldwell; but of this I must leave others to judge.

EDWARD CLARK.

New York, Feb. 25th, 1827.

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FOR THE FRANKLIN JOURNAL.

*Observations on an "Essay on the art of Boring the Earth for the obtainment of a spontaneous supply of water."*

NEW YORK, APRIL 30, 1827.

*To the Editor.*

SIR—I observed in your valuable Journal, some time ago, a favourable notice of one of the most absurd* Essays that I have ever met with, "on the art of boring the earth for the obtainment of a spontaneous flow of water, &c." in which the author maintains the practicability of obtaining water above the surface, in any situation which the borer chooses. I have been looking for a refutation, or exposure, in your late numbers, but perhaps you have been too much engaged to refute it yourself, and your correspondents have thought it useless to combat the absurdity of the new theory, or have been awed by the appalling appeal to facts, which is so confidently made in support of it. It would be a laborious undertaking to review the whole pamphlet of 46 pages, and it would occupy too much of your paper; suffice it to say, there is not a *single fact* stated in it, that militates in the slightest degree from the received, or if you please, the old theory of obtaining water; but wrong *inferences* to that effect, abound. The essay commences with observing that boring "has been known in Europe for the last fifty or sixty years. It was, however, but a partial operation, being no farther practised than to ascertain the presence of coal and other minerals, and to give a greater quantity of water to wells that did not, at all times, afford a sufficient supply." Allow me to make a few extracts from Dr. Darwin's "Phytologia," (my copy of which was printed in 1800) illustrative of the true theory. "Many modern philosophers have attempted to show, that all the continents and islands of the world have been raised out of the primeval ocean by subterraneous fires; hence the strata which composed the sides of mountains, lie slanting downwards, and one, or two, or more of the

* Extract as a specimen of the absurd—"There are, no doubt, large cavities at the bottom of the sea, into which the sea would undoubtedly fall, were it not upheld by the vast columns of gases that are present," page 33.—See also last paragraph of page 34, all 35, and part of page 36.

external strata not reaching to the summit when the mountain was raised up, the second or third stratum, or a more inferior one is there exposed to day. This may be well represented, by forcibly thrusting a very blunt instrument through some folds of paper, a bur will be raised, with the lowermost leaf standing highest in the centre of it." "On this uppermost stratum, which is colder, and is more elevated, the dews are condensed in large quantities" (in addition to the rains) „and, sliding down under the first or second, or third stratum which compose the sides of the hill; and either form a morass below, or a weeping rock, by oozing out in numerous places; or many of these less currents meeting together, burst out in a more copious rill." He also gives an account of "boring a hole near the Derwent in Derby, about fifteen yards deep; the water rose above the surface of the ground, and has continued to flow now for above twelve years, in rather an increasing quantity;" probably as the bored hole wore larger, "it supplies Dr. Darwin's house with two or three hogsheads of water a day; and Mr. Strutt has sunk a well for the use of his steam engine, 200 yards from the former, which supplies 100 hhds. per day." "At Hartford in Connecticut, there is a well which was dug 70 feet before water was found; and then, on boring an auger-hole through a rock, the water rose so fast as to make it difficult to keep it dry by pumps, till the hole could be blown larger by gunpowder; which was no sooner accomplished, than it filled and ran over, and has been a brook for near a century. Travels through America, London, 1789, Lane." And I could give you many more instances where boring for other purposes than to ascertain the presence of coal or other minerals, has occurred, and where water flows above the surface, in conformity with the above lucid explanation; nor do I believe there is an instance where that explanation will not prove the true one. The author of the Essay does not pretend that there is any well in this city* that flows above the surface of the ground; (deep wells or bores that are piped and made tight, and communicate with the water at a great depth below the surface that has filtered through the sand above, will here supply good water by means of a pump twenty or thirty feet long, is admitted) but for support, the new theory, lays great stress upon the evidence of the wells of Brunswick. I shall conclude this communication with an extract of a letter from a friend in New Brunswick, with whom I have conversed upon the subject, and of whose intelligence and correctness, there is no question. "Nos. 1, 2, 3, 4, and 8, are the only ones I am acquainted with; and I must say, that the author has certainly stated truths about them—but has not stated the whole truth. The course of the Raritan River here, for about two miles, is nearly north and south; and the banks for that distance, on one side or the other, are high, and almost perpendicular, and show the different strata as correctly as they could be found by boring, as all the strata in this neighbourhood dip to the north, and crop out at the south. This being the

* It is said the Manhattan Company have determined to have a well like the Widow's Cruise; but I fear if they confine themselves to this island, their bore will have to be as long as their charter—"as long as grass grows and water runs."

case, it signifies but little whether the boring commenced six feet, or sixty feet above the level of the river; and it is only important to know whether the strata bored through are higher where they crop out, than at the place of boring. In the five cases above named, the strata are much higher where they crop out, than the surface of the ground is at the wells." H. B. W.

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## THE PATENT OFFICE.

We had determined to publish, monthly, a list of the patents obtained in the United States; but have been prevented from doing this, in consequence of not having regularly received the lists from the office. The cause of this will appear from the annexed report, the subject of which, we regret to learn, was not acted upon by the last congress. Every disposition to promote our views, has been evinced by those having charge of the office, and the lists which we have received, have been furnished free of expense. We now recommence the publication, but there is an hiatus from the 14th of September, to the 1st of November, which we hope hereafter to be able to fill.

It is very desirable, that, in the lists, the object of each patent should be more fully expressed, than it now is; this, however, we can neither ask or expect, while there are not clerks to transact the regular business of the office. Measures ought to be taken to urge upon the national legislature, that attention to the patent laws, and to the arrangements of the patent office, which the great interests involved in them, so justly demand. With the hope of promoting this important object, we republish the document before us.

*House of Representatives, March 1st.*

Mr. Trimble made the following Report:

The select committee to whom was referred so much of the report of the secretary of state, of the 13th of January, 1827, as relates to the patent office, respectfully report:

The patent office was established by an act of April, 1790, "to promote the progress of useful arts." That act was repealed by the act of February 1793, and the office, since that date, has been regulated by the provisions of the latter act. This act secures to inventors the full and exclusive right to their respective inventions and improvements, for the term of fourteen years. It requires each inventor to file a petition, and deliver a written description of his invention or improvement, and of the manner of using it; and in the case of a machine, he is to give a full explanation of the principle, and the mode of application. These descriptions or specifications, together with the models, specimens, drawings, and written references, are to be deposited in the office, and preserved for the use and benefit of the inventor and the public. Each inventor is allowed to take out a patent upon his invention or improvement, upon his petition and specification, and the act declares that the same "shall be recorded in a book to be kept for that purpose in the office of the secretary of

state." The law further requires each inventor to pay thirty dollars into the treasury of the United States, before he presents his petition for a patent, and declares that 'the money thus paid shall be in full for the *sundry services* to be performed in the office of the secretary of state, consequent on such petition, and shall pass to the account of clerk hire in said office.'

The committee have thought proper to refer the house to some of the requisitions of the act of 1793, for the purpose of showing that the government undertakes to perform '*sundry services*' for each patentee when it grants a patent, and requires from each an *equivalent* for those services. Upon inquiry and examination at the office, it is found that the government has failed to perform part of those services; and that the failure has already been injurious; and is likely to become much more so, to the public, as well as to the patentees. None of the patents have been recorded, as the law requires, from the year 1802, to the 4th of March, 1825, and the Committee is satisfied that the failure is owing to the want of the requisite assistance of clerks in the office. The law allows only one clerk to assist the superintendent, and it is believed that two are indispensably necessary to record the patents as they issue, and perform the current business of the office. The present secretary of state directed an extra clerk to be employed in the business of recording patents, and with his assistance, the patents issued after the 4th of March, 1825, have been duly recorded up to the first of May, 1826. No provision was made for additional clerks at the last session of congress; and the extra clerk was dismissed; the consequence of which has been, that the patents issued since the first of May, 1826, are yet to be recorded.

The Committee consider it proper to inform the House that the models are not kept in preservation; and that the utility of the model office is very much diminished, in consequence of its deranged condition, the models being placed on the floor and shelves of the office, in the most irregular manner without any system, order, or classification.

It is the opinion of the committee that the government, after receiving from patentees an equivalent for its services, is bound, in justice to them and the public, to apply the money in performance of its promises: and that the failure on its part to have the patents properly recorded, and the models properly preserved, is in contravention of its statutory stipulations. It is the interest of the public and the patentees, that the records in arrears should be brought up as speedily as possible, and that, in future, the business of recording should be done, if possible, as fast as the patents issue.

The amount of money received into the treasury for fees on letters patent, from 1793 to 1826, is $135,690; and disbursements during the same time was only $63,757. It is certain that there is a balance, of at least, sixty thousand dollars in the treasury, applicable, under the law of 1793, to the account of clerk hire in the patent office, and it is manifest, that the proceeds of the office are nearly double the amount of its disbursements, including salaries, clerk hire, and all other expenses and contingencies whatever.

It is not the policy of the law, nor the intention of congress, to make the patent office a source of revenue; and the committee can see no reason why the money in the treasury, to the account of clerk hire, should not be applied to the service of the office.

It is believed that one or two extra clerks ought to be employed in the business of recording patents, until they bring up the records in arrear, and for that purpose the committee ask leave to report the following resolution:

*Resolved, by the Senate and House of Representatives of the United States of America, in Congress, assembled,* That the secretary of state be, and he is hereby, directed to employ two extra clerks in the business of recording patents in the patent office, who shall be compensated for their services, out of any balance in the treasury, applicable to the account of clerk hire in said office: *Provided,* that the salary to each shall not exceed the sum of seven hundred dollars.

(The resolution was read three times, PASSED, and sent to the senate for concurrence, and there laid on the table.)

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## *List of patents granted in the United States in* 1826.

FOR INVENTIONS AND IMPROVEMENTS.

In the windmill; to Moses Padley, New-York, Aug. 31st.

In hydraulics, called the relieving valve; to Wm. Lanphier, District of Columbia, Sep. 2d.

In the loom; to Samuel Chidester, New-York, Sep. 2d.

In the thrashing machine; to Archibald Douglass, New-York, Sep. 8th.

In the machine for singeing or dressing cloth; to Andrew Robeson, Massachusetts, Sep. 8th.

In the screw boot-tree; to George Nicol, Virginia, Sep. 8th.

In burning stone-ware without salt; to Sandford S. Perry, New-York, Sep. 12th.

In making, iron keyed, bands, with male and female rivetted lugs; to Edward Cooper, Virginia, Sept 14th.

In making glass knobs; H. Whitney and E. Robinson, Cambridge, Mass. Nov. 4.

In the printing press; Samuel Fairlamb, New-York, Nov. 4.

In a machine for cutting fur; Jeremiah Hubburd, James Town, N. C. Nov. 4.

In bilge levers to support ships; John Thomas, New-York, Nov. 6.

In the submarine rail-way; do. do. do.

In the domestic loom; Jeremiah Hubburd, James Town, N. C. Nov. 6.

In the foot gin for cotton; Isaac B. Barnes, Beaufort, S. C. Nov. 6.

In the steam engine; Elisha Bigelow, Baltimore, Nov. 6.

In fastening together the posts and rails of beds; William Bell, Lexington, Ken. Nov. 7.

In the fanning mill; Ovid Pinney and Jas. Olmstead, Caledonia, New York, Nov. 7.

In boring boxes for the hubs of wheels; Ebenezer Johnson, Lexington Heights, New York, Nov. 7.

In a machine for thrashing and winnowing grain; Sylvanus C. Hersey, Rochester, New-York, Nov. 7.

In the construction of furnaces, fire-places, &c. Social Rolph, Wales, New-York, Nov. 8.

In a rotatory steam engine; Elijah H. Reid, Lancaster, Kentucky, Nov. 10.

In the water wheel; Benjamin Raymond, jun. Beverly, Mass. Nov. 13.

In the making and grinding the currying knife; Samuel Brooks, New-York, Nov. 13.

In the machine for cutting cabbage, &c. F. Berkemeger and J. Dangler, Greenwich, Penn. Nov. 14.

In the method of drawing lotteries; William C. Conine, Baltimore, Nov. 14.

In the mode of fastening commode handles; William Price, Pittsburgh, Penn. Nov. 14.

In the steam generator; Daniel Phelps, Bath, New York, Nov. 14.

In the construction of boxes in which to press hay; Ezekiel Waterhouse, Gardiner, Maine, Nov. 14.

In the machine for spinning and reeling cotton yarn; Joseph Woodhull, Chester, New-York, Nov. 14.

In the atmospheric steam engine; William Willis, Charleston, S. C. Nov. 14.

In an instrument for husking corn; Howlet Bushnell, Norwich, Conn. Nov. 14.

In a machine for raising boats, &c. Alfred Warner, Rochester, New York, Nov. 16.

In a mode of dying hair; Joseph Herring, New-York, Nov. 16.

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## NOTICES.

*To correspondents.*—We have been compelled to postpone, until the next number, the article on canal boats, by J. Stott, the engravings not being yet finished. The communication from Colonel Long, on the use of anthracite, and bituminous coal, in generating steam, is delayed from the same cause.

*Deferred Articles.*—Although we have given an extra form, several Editorial articles, intended for the present number, have been crowded out, by the length of those upon the subject of Mr. Perkins's new engine, and upon the cause of explosions in boilers. We apprehend that this will not require an apology.

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### *Geological Society of Pennsylvania.*

A society under the above title is about to be organized. The name sufficiently indicates the design of its formation. Many of our most scientific fellow citizens are already enrolled in the list of members.

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The essay of T. W. Bakewell, on falling bodies, has just been received, and will appear in our next number.

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